AUSTRALASIAN RAILWAY ASSOCIATION

L.E.K.

Finding the fast track for innovation in the Australasian rail industry

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CONTENTS

The Australasian Railway Association (ARA) is the peak body for the rail sector in Australia and New Zealand. We represent more than 150 member organisations including passenger and freight operators, track owners and managers, suppliers, manufacturers, contractors and consultants. Our members include listed and private rail-related companies, government agencies and franchisees.

Executive summary

When Australia's first railways were developed in the 1800s, they catalysed economic and social development and connected distant settlements.[1] However, the absence of a national vision meant that the railways developed separately, with different standards and gauges.

Nearly two centuries later, successive reforms and investment have modernised and electrified these railways, and established a standard interstate rail network and a single national rail safety regime. But the original fragmentation remains, and continues to thwart optimal rail development in Australia.

Australia is embarking on its next major program of rail transformation – with $155 billion of rail investment planned in the next 15 years. These projects will embed the next generation of transformative rail technologies, with opportunities extending across the supply chain to local rail manufacturing, which is expected to see a return of growth to 1.5% per year for the next five years.

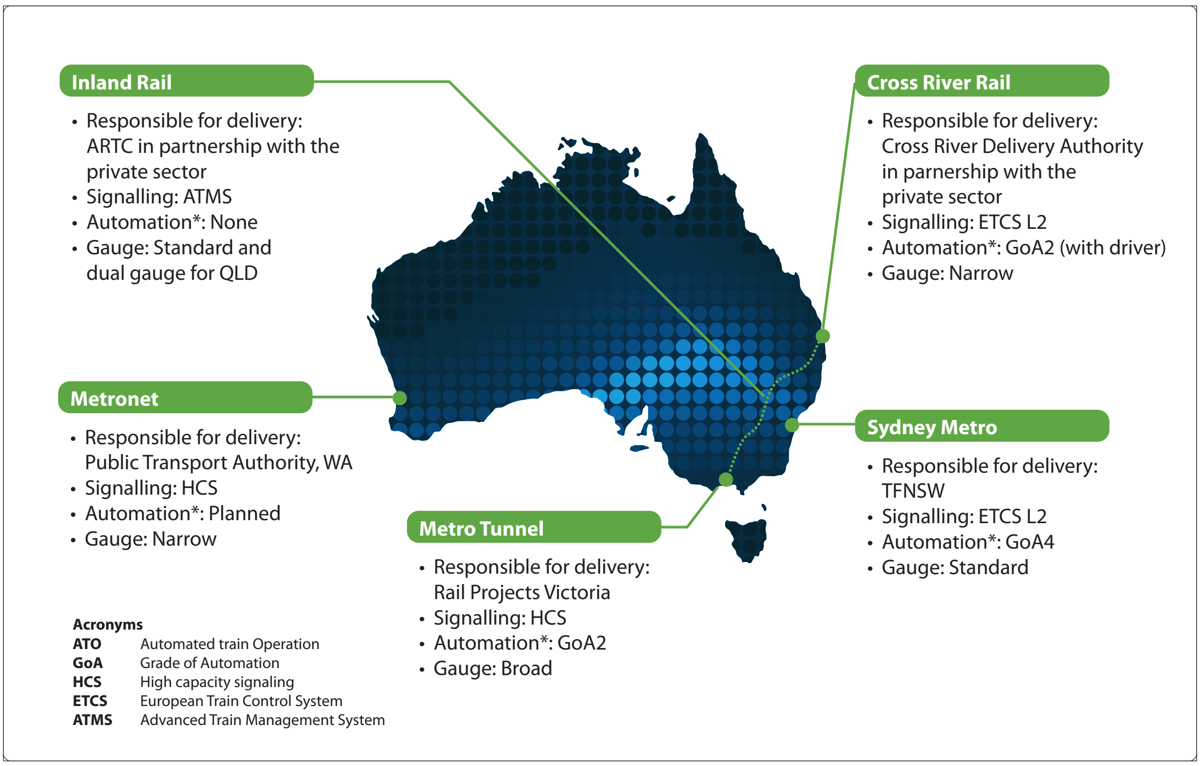
But there remains no national agreement on the signalling, automation or smart rail standards needed for a modern rail system in the 21st century. While technology offers network-scale benefits, Australia continues to develop different systems in different jurisdictions.

There is a wide range of innovations that are ripe for application to Australia's rail systems (Figure 2).

If Australia is to harness the great benefits of technology to decongest and decarbonise urban environments, better connect regional communities, and boost land transport productivity, it will need a more unified market for rail innovation, with national rules and a single playing field. Australia will need a national focus on rail innovation.

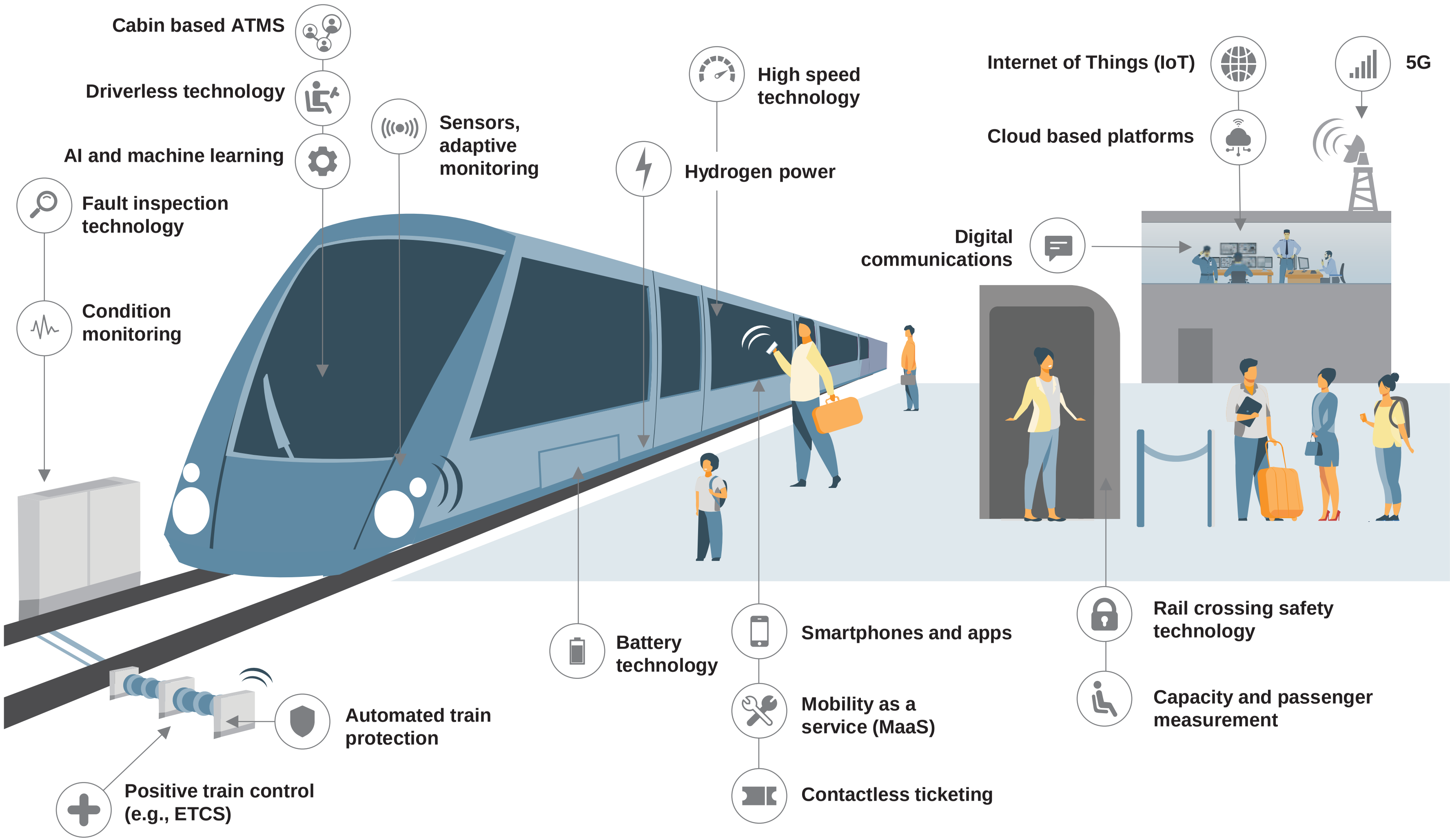
Australia currently lags behind global comparators in research and development (R&D) and commercialisation, and in rates of technology adoption.

Figure 1: Current marquee rail projects in Australia



Notes: *Degree of automation is measured by grade of Automation (GoA) means the driver operates the doors and handles emergencies with automated starting and stopping, while GoA4 refers to a fully automated driverless system.
Source: Project websites, ANZIP

Figure 2: Examples of new technology, innovation and digitalisation in rail



This research considered global benchmarks and consulted with ARA members, including industry suppliers and public and private rail owners and operators. The interviews brought to light considerable consensus on the reasons for Australia's uneven rail technology performance.

Fragmentation across rail planning and procurement, disconnects across the national rail innovation system, and a culture that has not been primed for innovation, are all major inhibitors to technology-enabled rail productivity. Some of the impacts of these challenges include:

- Multiple rail operators and owners, and multiple rules and type approvals, make Australia a challenging market for technology suppliers, who have multiple paths to market for each product
- Weak linkages across the value chain, and the recent closure of the Rail Manufacturing Cooperative Research Centre (RM CRC), will see the continuation of a small pool of local commercialisation
- State local content requirements inhibit the achievement of scaled rail manufacturing in Australia
- Rail planning, investment and procurement is risk averse and does not incentivise innovation well

On the other hand, there is a 'virtuous circle' between strong national rail research and productive and efficient railways. The implication is that rail innovation in Australia needs a focus both on driving collaborative research and on building a culture that demands innovation and continuous improvement.

This paper recommends a new national compact to boost the economic contribution and legacy of Australian research and industry for planned rail investment over the next 15 years.

The compact would have three objectives, each with recommended actions:

- **To make rail innovation a national priority:** A new national public body would drive national planning and coordination of investment, support long term R&D and commercialisation investment, and develop national capability and an export strategy for the sector
- **To develop a single market for rail technology:** A single market with common standards, nationally accredited testing, a national industry policy, and industry-standard training
- **To build a culture for rail innovation:** Ensuring best practice procurement and contracting, the development of states' smart rail strategies to build an investment pipeline for digital technology, and building the brand for Australian rail innovators globally

This is an ambitious compact that requires deep partnership across governments, industry and operators. The ARA is committed to policies that are in the national interest for rail innovation.

2. Why innovation matters to Australian rail

2.1 The benefits of rail innovation

The global market for rail technology is worth AU$362 billion, and is growing at 3.2% per year,[2] with almost all aspects of modern rail systems experiencing digital and technological disruption. In particular, the convergence of information and communications technologies (ICT) with rail operational technologies has changed the way that railways are planned, built, run and maintained.

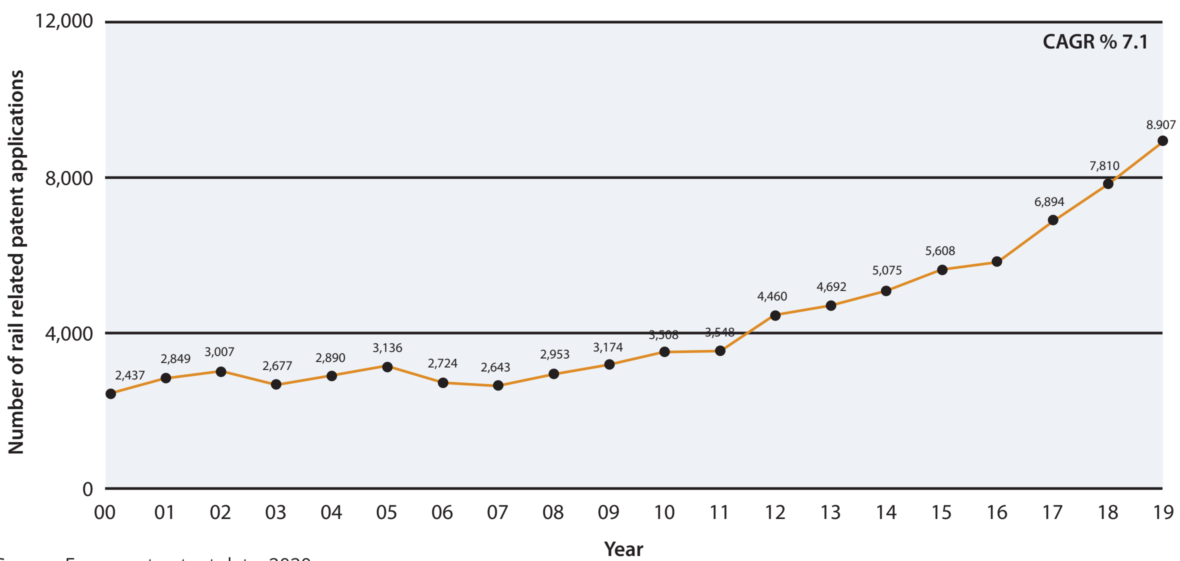
There is evidence that the pace of innovation in rail transport is quickening. One measure is the number of rail patents submitted globally each year, which has almost quadrupled in the past 20 years, with China alone submitting 8,500 patents in 2019.[3]

Applications that are being used in energy, manufacturing and defence are also transforming the opportunities for rail, with intelligent systems, automation, sensors, predictive maintenance, advanced asset monitoring, traction and train control technologies, and energy efficiency.

New technology and innovation can involve high deployment costs and complexity when integrating with legacy rail systems, but can deliver higher relative benefits than traditional projects, including:

- **Cost savings:** Building Information Modelling on complex rail construction in Germany reduced costs by 10%, with ongoing energy and maintenance savings[4]
- **Capacity:** The Rail Sector Deal in the United Kingdom (UK) is investing in data, digital technology and sustainability, with an initial estimate that it will deliver up to £31 billion pounds in benefits from more capacity, more frequent and reliable services[5]
- **Reliability:** The sensor arrays and artificial intelligence of MOXI, being used by VicTrack and East Japan Railway, have been able to predict adverse car and track conditions to better than 90% accuracy, improving safety, maintenance costs and allowing earlier action on faults[6]
- **Time savings:** ICT tools used to optimise online rail operations halved wait times between trains on Berlin's U-Bahn network, and enabled safer operation on high risk corridors[7]
- **Safety:** In the United States (US), preventative maintenance technology such as wayside detectors, smart sensors and infrared lasers assess the condition of bearings, axles and wheels, reducing mainline equipment-caused accidents by 36% over a decade[8]
- **Energy Efficiency:** Energy Storage Systems on Tehran metro yielded daily energy savings of 25%[9]

Figure 3: Rail patents submitted globally each year



Source: Espacenet patent data, 2020

2.2 A 'virtuous circle' exists between local rail R&D and innovative railways

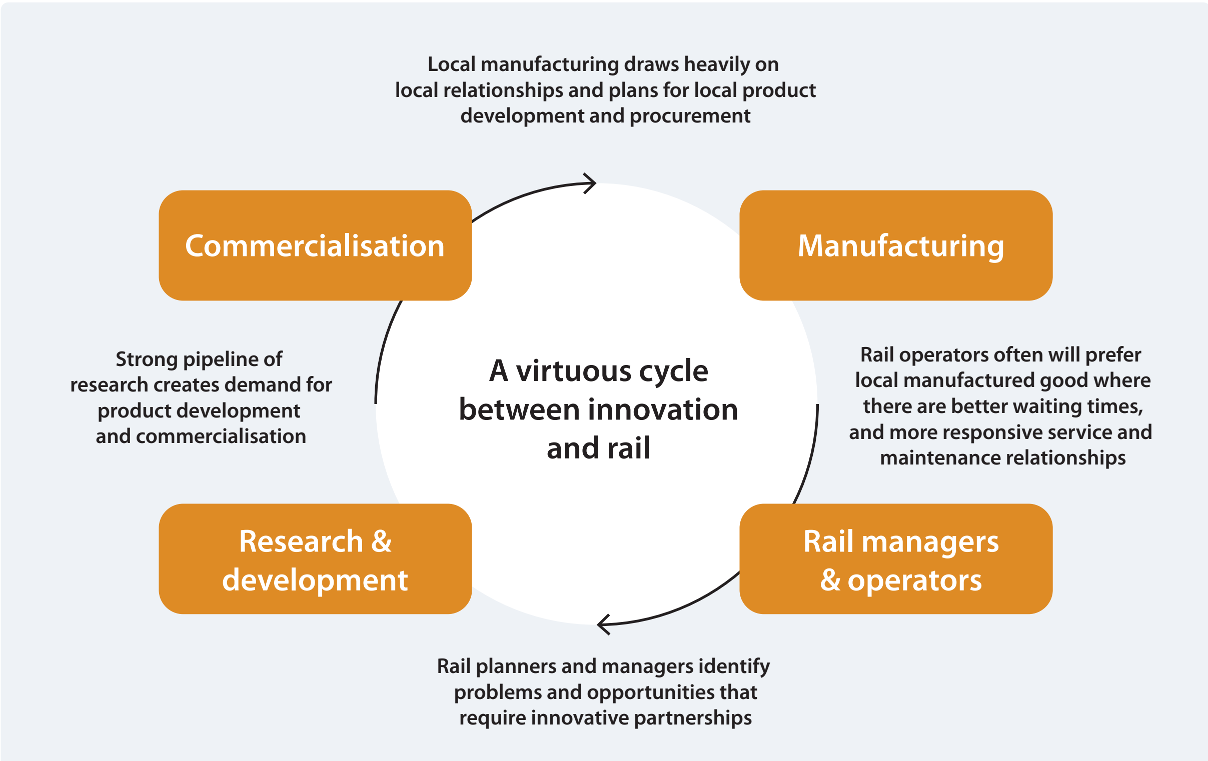
New rail technology requires significant cost and collaboration to develop, commercialise, manufacture and deliver at scale. Strong collaboration reduces the hurdles to success between stages of the value chain.

There are strong links between a country's rail innovators, manufacturers and rail managers, such that countries with stronger rail innovation systems tend also to have more innovative railway networks.

This study observed that while Australian railways source technology widely from the global marketplace, there are several important links across the value chain, between rail managers and the rail innovation system, comprising specialist research institutes, manufacturers and suppliers:

- **Rail operators want access to local suppliers.** Passenger rail operators prefer to buy locally, reducing wait times for equipment, or relying on existing relationships for ongoing servicing, maintenance and repairs
- **A strong pipeline of operator investment supports growth in local manufacturing.** A steady pipeline of investment sustains local manufacturing capability and its supply chain, and enables knowledge and skills to be transferred to new clients
- **Local manufacturers benefit from the commercialisation of local research.** A major factor for advanced manufacturing is the 'feeder' system of local research and commercialisation
- **Researchers benefit when rail operators need new solutions and fund research.** Examples of partnerships between rail operators and researchers include the development of condition monitoring between the Monash Institute of Rail Technology (MIRT) and the Australian Rail and Track Corporation (ARTC), and the ARTC's partnership with Lockheed Martin to develop the Advanced Train Management System (ATMS)

Figure 4: Interrelationships between Australian Railways and the Rail Innovation System



2.3 Australia is at a crossroad on rail innovation and investment

Australia has a large land mass, extremes of temperature and operating conditions, and a relatively small urban population. As a result, its railways can struggle to be cost efficient. For example, the share of operational costs recovered by farebox revenue by Japanese operators is up to 15 times the level of recovery of some Australian passenger railways.[10]

However, this need for lower cost productivity gains is the strongest case for Australian railways to invest in innovation. The Australian experience demonstrates plenty of examples where new technology has delivered sizeable productivity improvements:

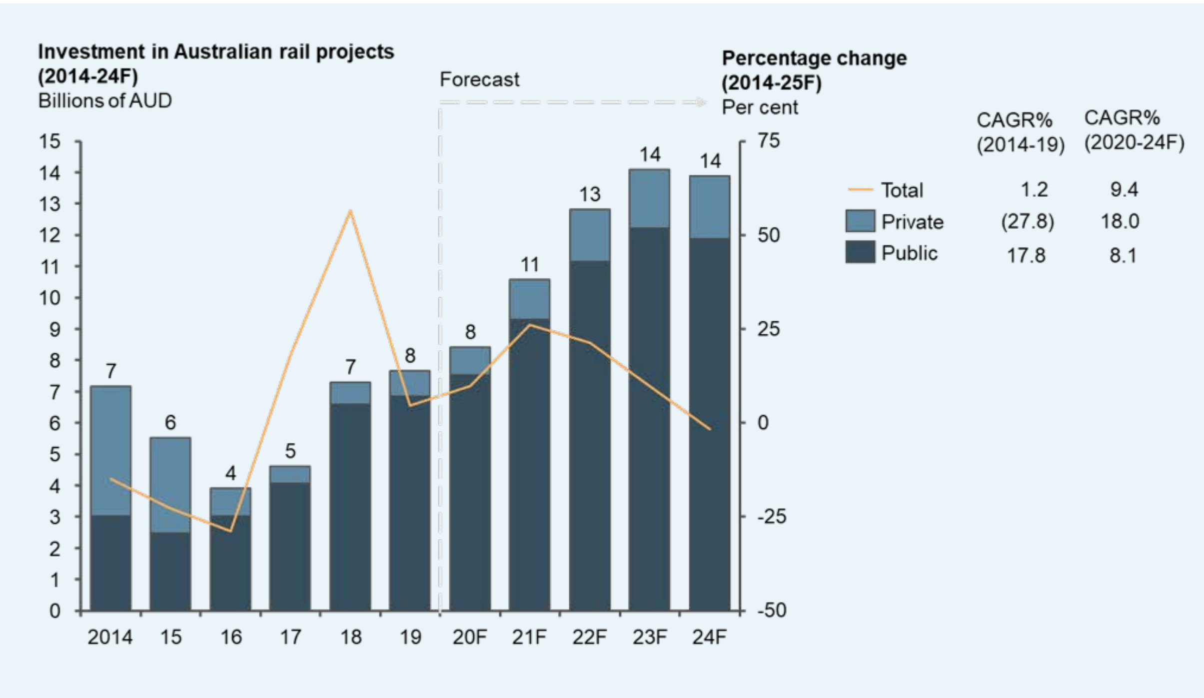
- Sydney Trains has historically recovered around 20 cents of every dollar in operational spending, whereas Sydney Metro – its recently built, automated counterpart – recovers more than 28 cents in the dollar, and expects to recover around 60 cents in every dollar by 2021[11]
- Aurizon's operating costs have shown a 33% reduction since 2015, linked strongly to the introduction of new technologies, with trip optimising technology reducing fuel consumption by 8%, wheel impact load detectors reducing unplanned maintenance costs by 22%, and automated condition monitoring technology leading to savings in consumables[12]

Australia is due to spend $155 billion on rail construction over the next 15 years – a once in a generation opportunity to decongest and decarbonise urban transport, connect regional communities, and boost land transport productivity across the country. Efforts now to maximise innovation and impact across this program will set up the Australian rail sector for future productivity.

And with the closure in June 2020 of the RM CRC,[13] there is a leadership gap in the national landscape for locally developed solutions and products. This 'gap' may well be a factor in Australia's ability to respond competitively in a post-COVID environment, where advanced manufacturing is recalibrating global supply chains to ensure resilient and efficient local supply.

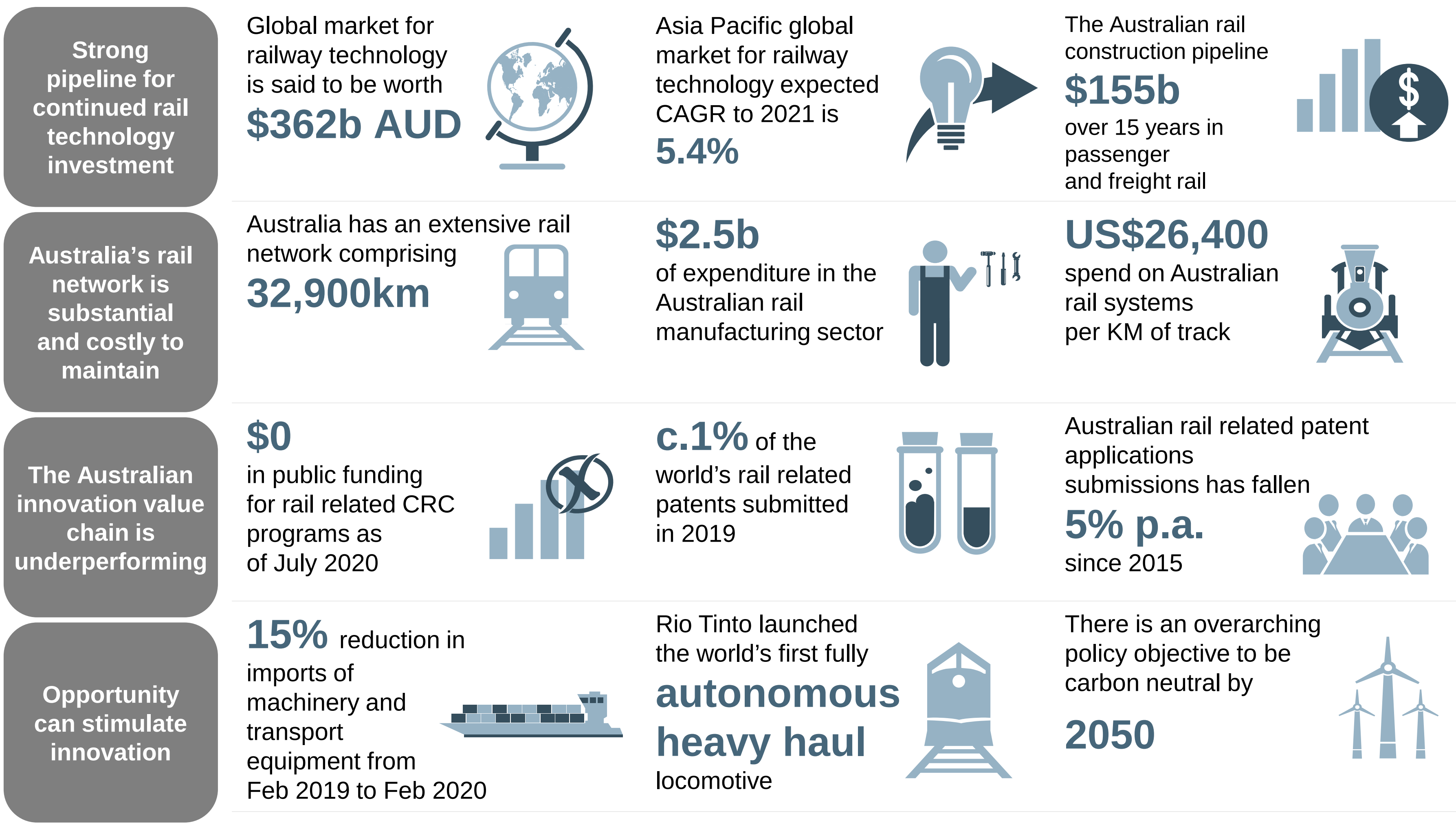
Australia is therefore at a crossroad, with a landmark opportunity to ignite the national field for collaboration and innovation, with potential direct application on Australian construction projects.

Figure 5: Investment in Australian rail projects over the next decade



Source: BIS Schrapnel data, 2020

Figure 6: Snapshot of Australian rail innovation 6



Source: Alstom Annual Report 2018/19, Allied Market Research, IBISWorld, RMCRC Annual Report, Patent Lens, Australian Bureau of Statistics, Rio Tinto, The Guardian

3 How Australian rail compares globally

While Australia has globally recognised research capability and has developed leading examples of rail technology, it continues to lag behind global comparators on levels of R&D investment, product commercialisation, and technology adoption readiness.

When compared to globally leading, high performing rail systems, Australia tends to demonstrate lower degrees of structured collaboration from development through to procurement.

This section benchmarks Australia against four countries, Japan, the US, the UK and Germany – four comparator countries with a similar mix of passenger and freight rail markets, and private and public ownership, albeit different in terms of market size and network characteristics.

3.1 National rail R&D investment in Australia lags behind global peers

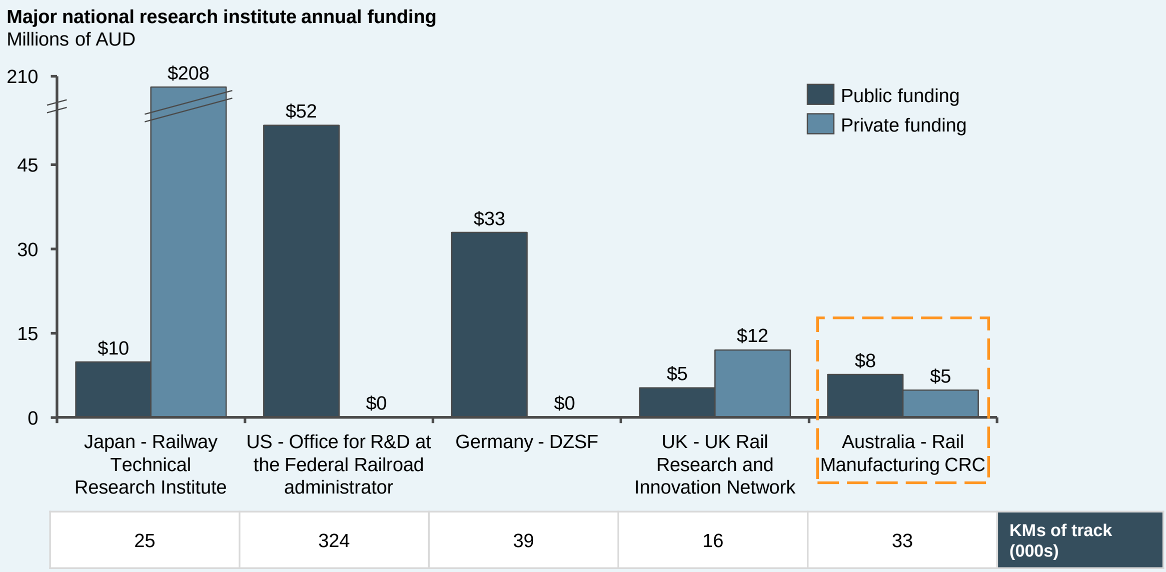
National funding in Australia for rail R&D has historically been significantly lower than in comparator countries – and it has also leveraged lower levels of private investment.

Australia's RM CRC received on average 15% of the annual budget of its American counterpart, and attracted far lower levels of private investment also (see figure 7).

The countries that were studied all had a centralised public funding body for national rail research. These bodies tended to invest directly in R&D activity, broker collaboration between researchers and industry and manufacturing partners, and establish links between public funding and national priorities.

- ***Australia's RM CRC*** agenda was set by the Australian rail industry road map, with a broad focus on several categories, such as power and propulsion[14]

Figure 7: Major national research institutes' average annual funding



Note: The funding period varies between institutes – DZSF funding is for FY20, RTRI funding period refers to FY18, RMCRC funding is calculated as the six year average, UKRRIN funding is calculated as a 10 year average, Office for R&D at the FRA funding is 2019 calendar year figure; Publicly funded research institutes also receive funding from private organisations

Source: FRA, UKRRIN, RTRI long term plan 2020, RMCRC annual reports, RBA Exchange Rate Data, BITRE, Statista, Ministry of Land, Infrastructure, Transport and Tourism, L.E.K. Research and Analysis

- **UK's Research and Innovation Network (UKRRIN)** research direction is set by the university and industry participants, with an objective of delivering research to meet the specific demands of the UK's rail industry[15]
- **Japan's Railway Technical Research Institute (RTRI)** research agenda is set in collaboration with the JR Group as well as the national government, so priorities are aligned and targeted research can be undertaken[16]

In Germany and Japan, national government support for rail research extends further, to in-house capability within the national railways.

- **Germany:** the majority of Germany's freight and long-haul passenger rail infrastructure is owned and operated by Deutsche Bahn (DB), a company wholly owned by the German government.[17] In 2019 DB incurred c.AU$45m of R&D expense with a focus on sensor technology, data communication and the testing of driver assistance systems[18]
- **Japan:** the JR Group is a federated collection of seven government and private companies. The most prominent of these is JR East – which in 2019 spent c.AU$280m on R&D initiatives such as testing hydrogen energy powered railcars, developing the next generation Shinkansen high speed rail railcar, and advancing Automatic Train Operations towards Grade of Automation 3 and 4[19]

An indication of R&D effectiveness is the extent to which publicly funded R&D also attracts private investment from operators and other funding sources. The RM CRC required that an Australian industry partner would be involved with an Australian research organisation as a condition of grant funding.[20] Similarly, the RTRI and UKRRIN focused on leveraging partnerships through public funding.

For every dollar of public funding, the RM CRC attracted 63 cents of industry investment into national projects. By comparison, each pound of investment by UKRRIN is matched more than twice over by private funding. In Japan, private investment through the national coordinating body was 20 times that of public funding.

In Australia, the role of the federally funded RM CRC was also supported by the Australasian Centre for Rail Innovation (ACRI) which serves to broker R&D and foster greater collaboration. However, the closure of the RM CRC and its research program in June 2020 leaves ACRI as the sole coordinator for rail R&D in Australia, without direct federal funding support or investment funding for national projects.

CASE STUDY:

A coordinated approach to rail research, *United Kingdom Rail Research and Innovation Network (UKRRIN).* The UK's Rail Research and Innovation Network is regarded as a leading example of a rail R&D partnership

- UKRRIN was established in 2018 as a partnership between the rail industry and higher education, providing a coordinated research effort on behalf of 11 universities as well as 17 industry partners including Bombardier, Alstom and Siemens[21]
- UKRRIN is comprised of four centres of excellence covering rolling stock, infrastructure, digital systems, and testing[22]
- The network received £28m of government funding and £64m of funding from industry partners to support development and innovation activities at these centres
- Objectives of UKRRIN are twofold:
  - To support the UK rail sector to develop, deliver and deploy new technologies
  - To radically increase UK rail productivity and performance by delivering transformational innovations and accelerating its uptake[23]

"...The launch of UKRRIN marks a ground-breaking partnership for innovation in UK rail and a step change in industrial research investment. By bringing together leading UK universities and industry, we can ensure that developments being made through academic research can be commercialised to deliver transformative changes across our railway network. ... "

Jo Binstead, Head of Innovation at Siemens Rail Systems[24]

UKRRIN

MECHANISMS THAT SUPPORT INNOVATION AND TECHNOLOGY ADOPTION

- Public funding for national innovation priorities, to foster collaboration across sectors
- Strong industry/buyer involvement at R&D stage
- Larger rail companies have capacity to invest more in internal R&D initiatives and to commercialise innovation in house

3.2 Commercialisation activity in Australia has weakened in recent years

Australia's rail patents make up c.1% of the global total, and both Australia and New Zealand have seen a declining trend in rail patents activity over the past five years.

Commercialisation is the process of bringing new technology and intellectual property (IP) to market. In the rail sector, the conversion of research into usable applications for large systems involves multiple steps, significant cost, and a high risk of failure.

While it is not the only indicator of commercialisation activity, the protection of IP through active and registered patents can indicate the strength of commercial appetite for innovation in that market. The share of patents that *remain* active can indicate the rate of success of 'pull through' of new ideas into commercial products.

Germany, the US and Japan together account for c.15% of total rail patents, with China being the largest submitter of global rail patents, accounting for 65% of patents submitted in 2019.[25]

3.3 Rail commercialisation activity in Australia is more fragmented

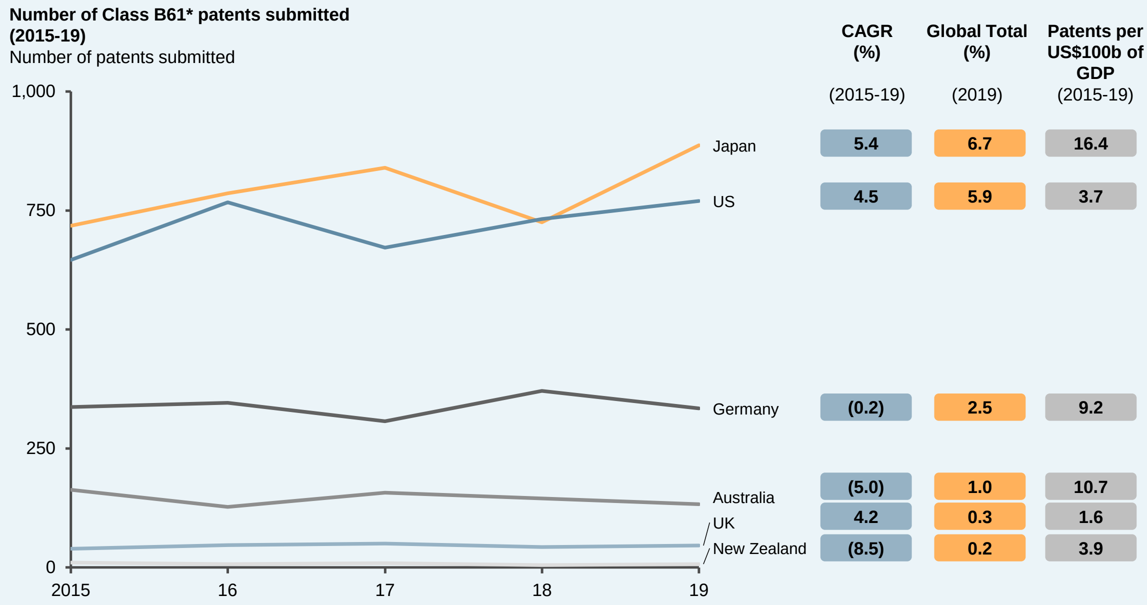
Australian commercialisation activity is more fragmented than in other countries studied. In comparator jurisdictions, the top five patent submitters accounted for between 25-55% of all patent submissions in most comparator jurisdictions – with patents submission more concentrated in Japan, the United Kingdom and New Zealand than Australia and the United States.

Rail commercialisation tends to be highly concentrated amongst large global companies, with international reach and vertical scale across rail technology development, manufacturing, distribution and servicing.

Where there is a high level of concentration, and a large volume of patents, it may indicate a strong presence by major rail suppliers, and that market's higher commercial significance to major suppliers.

No publicly funded body appears in the top 5 rail technology patent submitters in any jurisdiction, with the exception of the RTRI in Japan which undertakes research on behalf of rail companies.

Figure 8: Number of rail technology patents submitted



Note: *Patent Class B61* (rail related industries). Under the International Patent Classification system, rail related patents include a broad spectrum of rail related technologies, e.g., rail vehicle suspension, signalling systems and automatic train control technologies
Source: ESpace Net Patent, L.E.K. Research and Analysis

CASE STUDY:

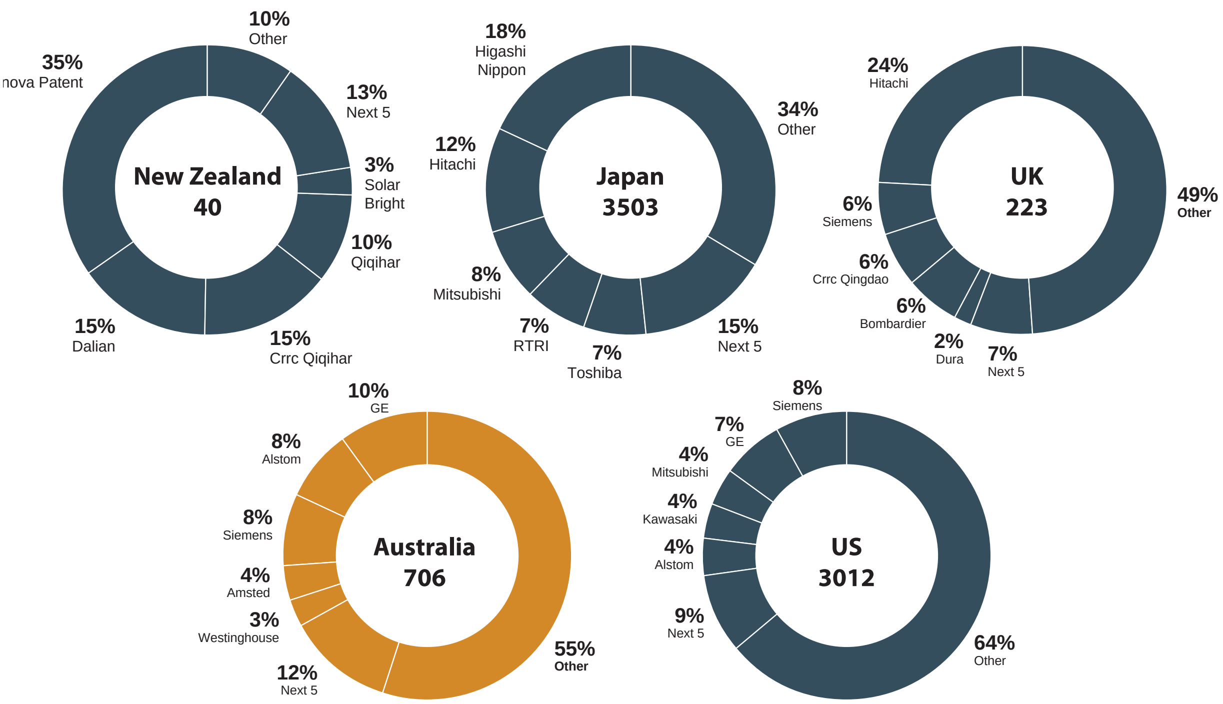
Government commercialisation support enabled 'pull through' of Alstom's hydrogen powered trains from R&D through to commercialisation

- Alstom was provided with €8.4 million of German government funding to commercialise hydrogen and fuel cell technologies in their Coradia iLint[26] prototype train, which Alstom developed in response to growing community concern over fossil fuel use[27]
- The commercialisation funding allowed Alstom to develop and then showcase their prototype hydrogen train at the InnoTrans international rail trade fair[28] - which provided Alstom with exposure to potential technology buyers
- Subsequent to showcasing Coradia iLint at InnoTrans, the Lower Saxony regional government purchased 14 hydrogen trains to use on their local passenger services, which have been operational since late 2018[29]
- Alstom undertook much of the commercialisation work at their own test track,[30] which is likely to have accelerated the 'go-to-market' process

MECHANISMS THAT SUPPORT INNOVATION AND TECHNOLOGY ADOPTION

- Large, vertically integrated companies are more easily able to commercialise technology, with internal 'route to market' capability
- Development may have a stronger rate of success when it responds to a close understanding of railway owners' and operators' unmet needs

Figure 9: Proportion of class B61 patents submitted by the largest five parties in each jurisdiction**



Note: *Patent Class B61* (rail related industries)
**Top 5 patent holders are called individually, while the 5th-10th largest patent-holders are grouped together as "next 5", and the rest are counted as "other".
Note: Germany has been excluded from the analysis due to the data being unavailable through Lens Patent
Source: Lens Patent , L.E.K. Research and Analysis

3.4 Australia has been slower to adopt major rail technologies

While Australian resource companies have led the world with rail technology and innovation, its passenger and freight rail networks have historically been much slower to adopt new technology.[31] Figure 10 below outlines the timeline of major technology adoptions.

Driverless Trains

- Australia's miners were the first pioneers of heavy haul driverless trains. Rio Tinto piloted Autohaul (a driverless train program) for their private iron ore haulage network in the Pilbara in the late 2000s. Rio Tinto's full adoption of driverless trains was delayed by the Global Financial Crisis and total automation was completed in June 2019[32]
- However, Australia's first use of driverless trains in passenger transport (the North West Metro in Sydney in 2019) occurred well after comparator jurisdictions. London's Victoria line became semi-autonomous in 1967,[33] and Japan implemented fully autonomous passenger trains in 1981[34]

High Speed Rail Technologies

- High speed rail (HSR) technologies have had a long lead time. Japan first developed and implemented HSR technologies in 1964[35] and expanded its network in stages to 2,700km of track.36 Adoption was driven by Government policy, as part of Olympic Games preparation and to link dense regions and cities
- The European Union's (EU) plan to have a single trans-European HSR line drove Germany's adoption in the 1980s. The US announced plans for HSR in 2010 (although the project is currently on hold[37]), and the UK has been operating HS1, connecting London to Europe through the channel since 2007, operating at over 300kmh[38]
- Australia has established a National Faster Rail Agency, and is beginning to plan for significantly improved rail speeds, but is yet to adopt or apply HSR technology[39]

Positive Train Control

- Positive Train Control (PTC) has been implemented in the US (2008), UK (2011) and Germany (2015) with the strong support from respective national governments. Various PTC systems have been implemented in Australia, with some states still to adopt
- PTC allows networks to safely run trains closer together and at higher speeds, increasing their operational capacity.[40] The most common system is the European Train Control System (ETCS)
- The US has been an earlier adopter of digitised and autonomous train control technology, mandating PTC in 2008 to improve safety under the Rail Safety Improvement Act.[41] As of May 2020, PTC systems are in operation on 98% of all PTC-mandated routes. Mandates were supported with $2.6 billion in federal government grants
- Other benchmarked jurisdictions have adopted some form of PTC. The UK began its roll out in 2011 and Germany in 2015. In 2019, the EU issued a directive for a minimum number of kilometres to have ETCS by 2030 in each country[42]
- The rate of PTC adoption has varied in Australia. The ARTC first implemented ATMS in 2013.[43] Both Queensland and NSW are planning to implement ETCS Level 2. In 2018, NSW announced an $880m deployment to be delivered in the early 2020s,[44] while Queensland announced that this is being delivered as a part of the Cross River Rail project, due to be completed in 2024[45]
- There are no specific plans to adopt ETCS in Victoria, although the under-construction Metro Tunnel will be fitted with High Capacity Signalling (HCS) technology, which is similar in function to ETCS. CPB Contractors and Bombardier are delivering the system[46]

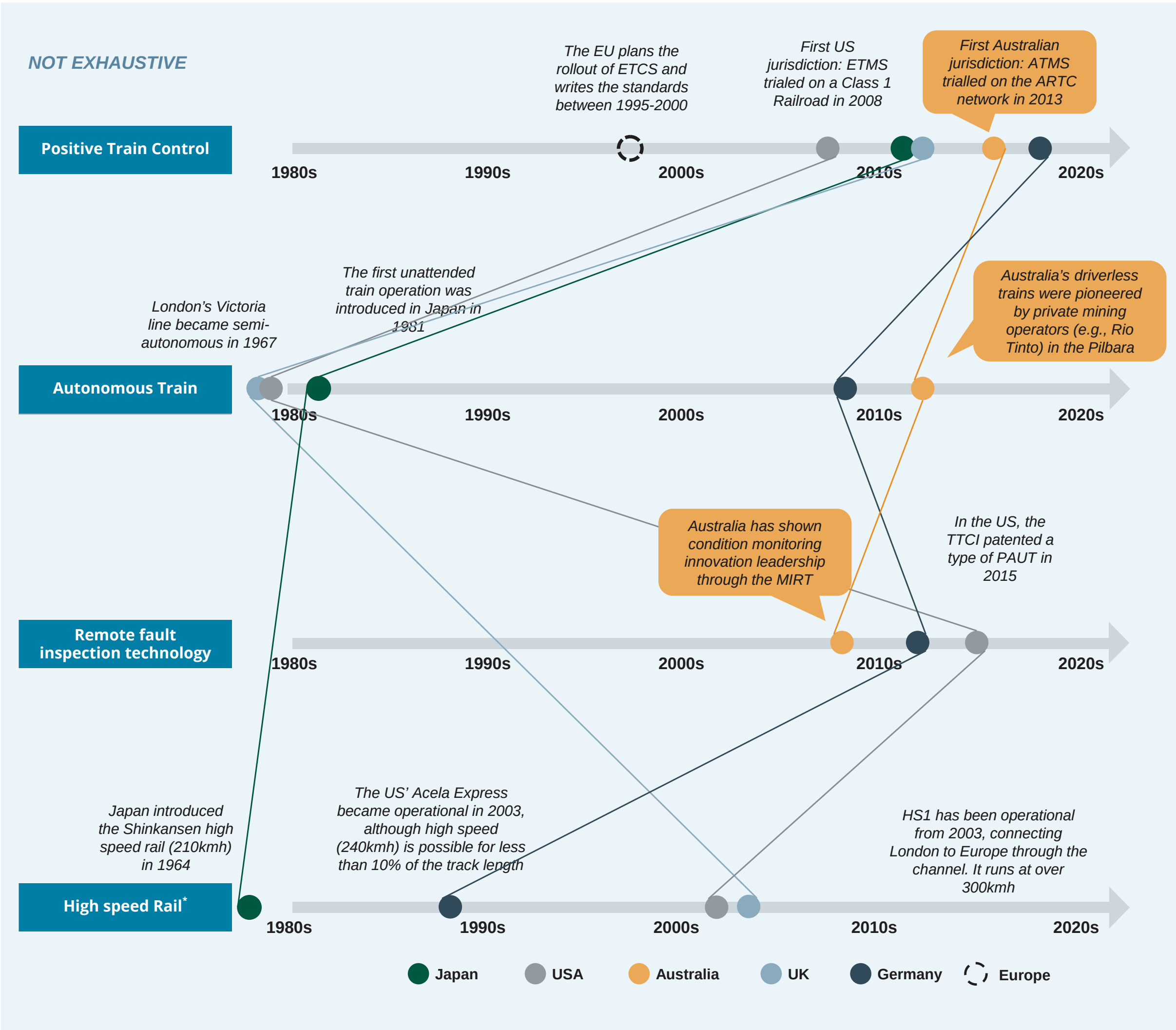
In May 2020, the Australian Government announced support to accelerate the deployment of ATMS, with an initial focus on Australia's freight rail network.[47] This important step will support greater interoperability and standards harmonisation, an issue highlighted in Australia's Transport and Infrastructure Council's National Rail Action Plan (NRAP)[48]

The technologies identified here are indicative of historical readiness to adopt new technology. However, there is a broader spectrum of applications than these, from innovations in design, construction, management, resourcing, through to digitisation and data management. These ongoing innovations have broad applicability across the rail industry and the sharing and promotion of these (where it is not related to competitive advantage) is important.

MECHANISMS THAT SUPPORT INNOVATION AND TECHNOLOGY ADOPTION

- Simplifying standards and ensuring they are consistent between jurisdictions where appropriate can drive uptake of new rail innovation
- Strong links between i) safety and technology adoption, and ii) productivity and technology adoption

Figure 10: Major rail technologies adoption timeline



Source: L.E.K. Analysis

3.5 Australia spends relatively more than others on its rail systems

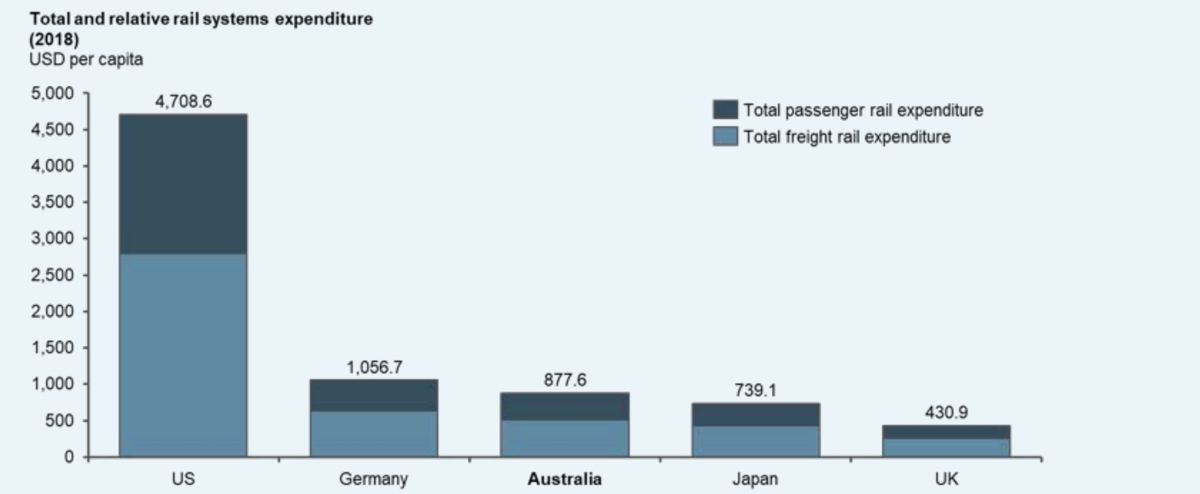
Across the comparator countries, the levels of spending on rail system improvement varies considerably, and appears to be driven by network size. The US, with a significant network, spends considerably more than Japan which has a dense but relatively smaller rail network.

Figure 11 highlights that rail system expenditure is strongly linked to the size of the rail network, with Australia in the middle of the pack. By comparison, Australia has around twice the rail kilometres of the UK, and spends roughly the same amount per kilometre.

As an indication of investment effort and impact, this reveals a key point of disadvantage for Australia. It highlights the immense size but sparseness of the Australian rail network, and the high relative cost adopting new systems.

A comparison of various Japanese rail operators against Australian rail operators show this another way – that the ratio of farebox revenue to operating costs is a fraction of what is achieved by their Japanese counterparts.

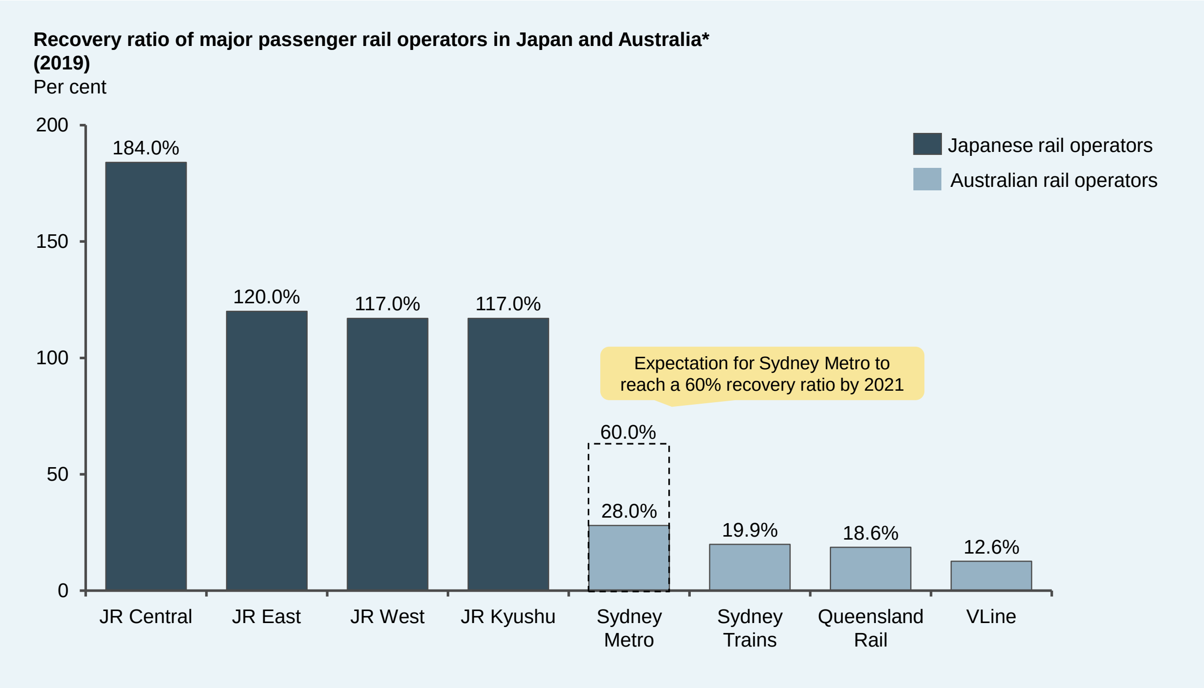
Figure 11: Absolute and relative expenditure on rail systems



	US	Germany	Australia	Japan	UK
Total rail kms (000's)	323.5	39.2	32.9	25.0	16.3
Total spend per km (USD,000)	14.6	27.0	26.4	29.6	26.4

Source: Allied Market Research, BITRE, L.E.K. Research and Analysis, BITRE, Statista, Ministry of Land, Infrastructure, Transport and Tourism

Figure 12: Recovery ratio for major rail operators in Japan and Australia



Source: Company annual reports

3.6 Australia's rail manufacturing has been contracting but is forecast to rebound

Revenue in Australia's rail manufacturing sector has contracted by an average rate of 1.6% per year, and sector revenue is now less than half that achieved in the rapidly growing UK market, and one-tenth that achieved in the USA.

This contraction was driven by cheaper imports from within the Asia Pacific, the decline of component manufacturing across rail and automotive industries, and sporadic local demand for manufacturing.[49] While global performance shows that annual revenues can be volatile in this sector, growth occurred in comparator markets, with the UK sector growing on average by 4.8% each year.

The rail manufacturing sector is part of the rail innovation ecosystem. Skills required for higher value added manufacturing are in part transferrable along the innovation chain to assist with commercialisation, and earlier in the innovation chain to support applied R&D efforts. An Australian-based manufacturing sector also allows for innovation to be more closely tailored to Australia's unique rail operating environment.

Rail manufacturing in Australia tends to be suited to lower volume, high value goods.[50] For this reason, a steady pipeline of planned rail investment is needed to build and to sustain local manufacturing capability. If a strong pipeline exists, Australian firms will scale their facilities and workforce accordingly, and retain staff between projects. Therefore, industry observers expect a return to growth in local rail manufacturing over the next few years.

Despite this contraction, Australian rail manufacturing productivity has increased marginally since 2007

Productivity growth refers to achieving higher outputs from a given level of inputs, with technology and innovation a driver of this productivity. In rail manufacturing, productivity growth can reflect increased innovation in construction methodology and/or capital investment in technology.

Australian rail manufacturing productivity has increased marginally since 2007, with growth around 2% p.a. with incremental increases following a decline from 2010 in 2011. The UK rail manufacturing productivity outperforms both the US and Australia, trending upwards at 2.8% p.a.

Anecdotal and industry evidence points to a shift towards higher value added activities, with greater focus on assembly, servicing and maintenance activities. However, the relatively small increase in productivity has not mitigated the overall reduction in output from the manufacturing sector over the last decade.

CASE STUDY:

Efforts to support local rail manufacturing in the USA may have acted as a barrier to innovation

In the US, the Federal Railroad Administration has been bound by the *Buy America* Scheme when procuring or contracting manufacturers since 2016.[51] The Buy America rules require at least 60% (moving to 70% in 2020)[52] of the value of the subcomponents for rail assets and equipment to be produced in the United States and that final assembly happens on US soil.

As most rail projects include some form of federal assistance almost all railcars experience some form of domestic assembly, reducing the level of imports. This was further compounded by the one-year ban on importing Chinese railcars between 2018 and 2019, after US manufacturers were concerned about China Railway Rolling Stock Corporation gaining market power.[53]

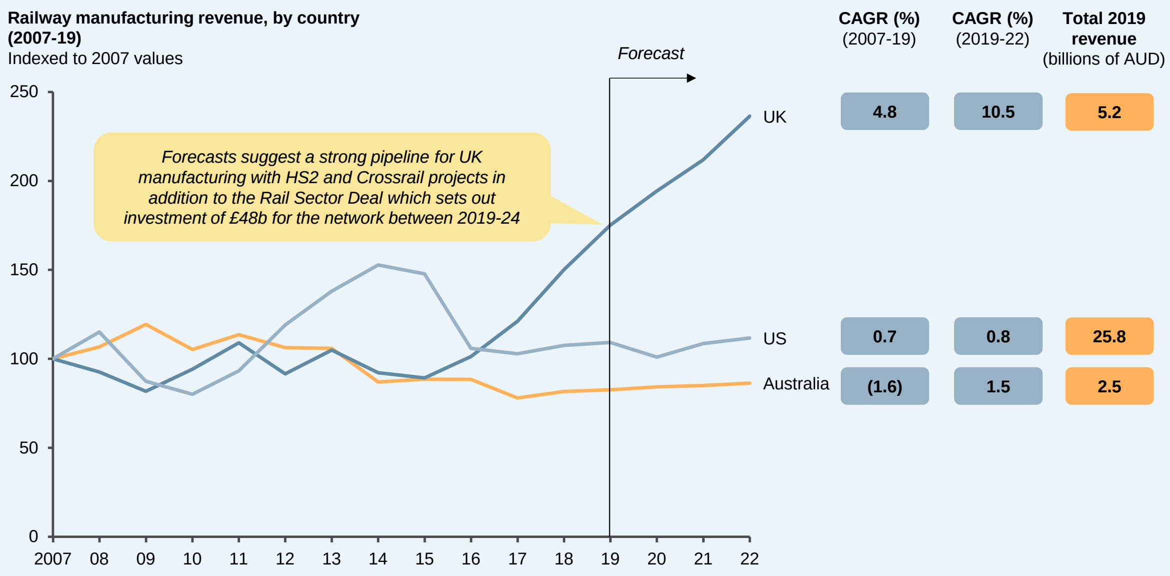
It is argued that the *Buy America* scheme increases the cost and completion time of many projects, resulting in fewer projects being undertaken.[54] This is thought to have contributed to low levels of technology adoption in the American rail system, and is a contributing factor to the US's outdated locomotive and rolling stock fleet.[55]

Similar policy approaches are in use in Australia, with some state governments supporting local manufacturing and local employment by introducing state-specific local content requirements, which are further discussed in Chapter 4.

MECHANISMS THAT SUPPORT INNOVATION AND TECHNOLOGY ADOPTION

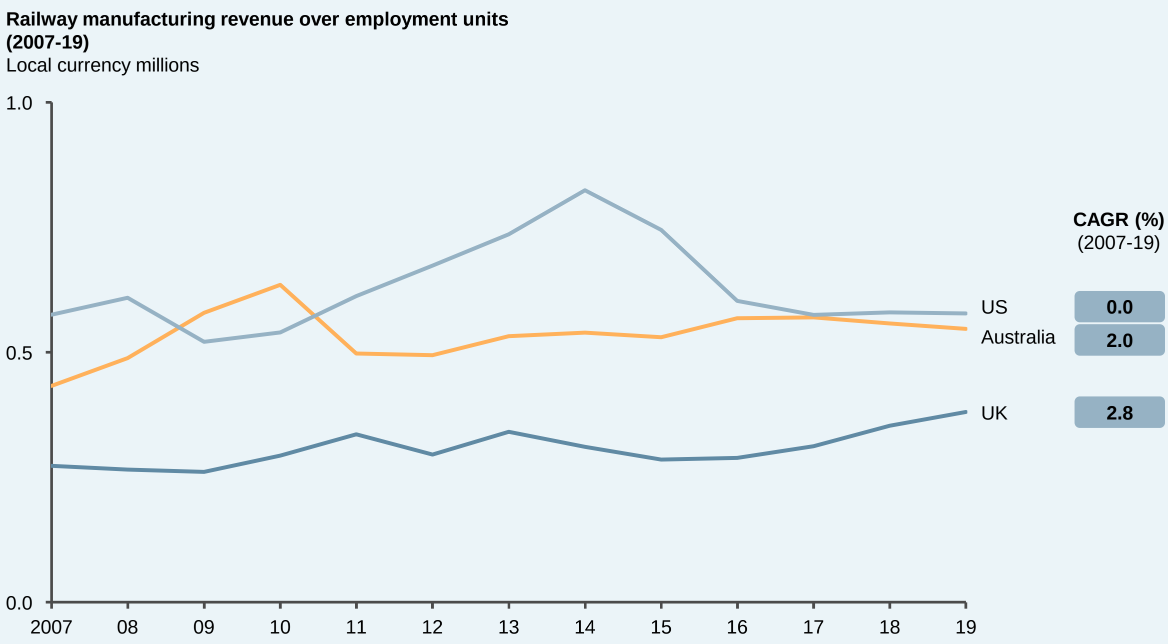
- A steady pipeline of planned rail projects can enable Australian firms to plan their capability and facilities
- 'Buy Local' initiatives can foster local innovation, but must be structured appropriately to support the efficient delivery of projects

Figure 13: Rail manufacturing revenue



Source: Ibisworld, L.E.K. Research and Analysis

Figure 14: Rail industry revenue over employment units



Source: Ibisworld, L.E.K. Research and Analysis

4. Barriers to rail innovation in australia

The Australian rail market can be challenging for technology suppliers, with multiple state and territory rules and standards, state-based local content procurement preferences, and multiple rail owners, operators and managers. This high degree of fragmentation creates deep structural barriers to the efficient take-up and procurement of new technologies.

The rail and technology suppliers who were consulted for this study universally identified the challenges of working across eight jurisdictions in Australia, a country whose population is less than a third the size of Germany.

However, they also cited a second significant factor – culture. Australia, relative to other countries, was seen as more reluctant to experiment and trial new technologies, safety-conscious to the point of high risk aversion, and unwilling to mobilise major change management around new technologies and systems.

4.1 Market fragmentation in Australia slows the path to market for new technology

The Australian buyer market is highly fragmented

The Australian rail sector is highly fragmented, with both national and state based rail systems. This fragmentation creates a fractured buyer market for new technology, and requires multiple paths to market for the same products.

By comparison, the New Zealand rail market is less complex. Kiwirail, a state owned entity owns and operates New Zealand's intercity passenger and freight network. Transdev is contracted to operator the inner city networks in Auckland and Wellington.

One implication of market fragmentation is that individual rail operators do not benefit from scale efficiencies. Likewise, a supplier has more numerous sale opportunities, but higher costs for reaching individual buyers, with small orders each requiring some modification.

Figure 15: Illustration of fragmentation across the Australian rail market

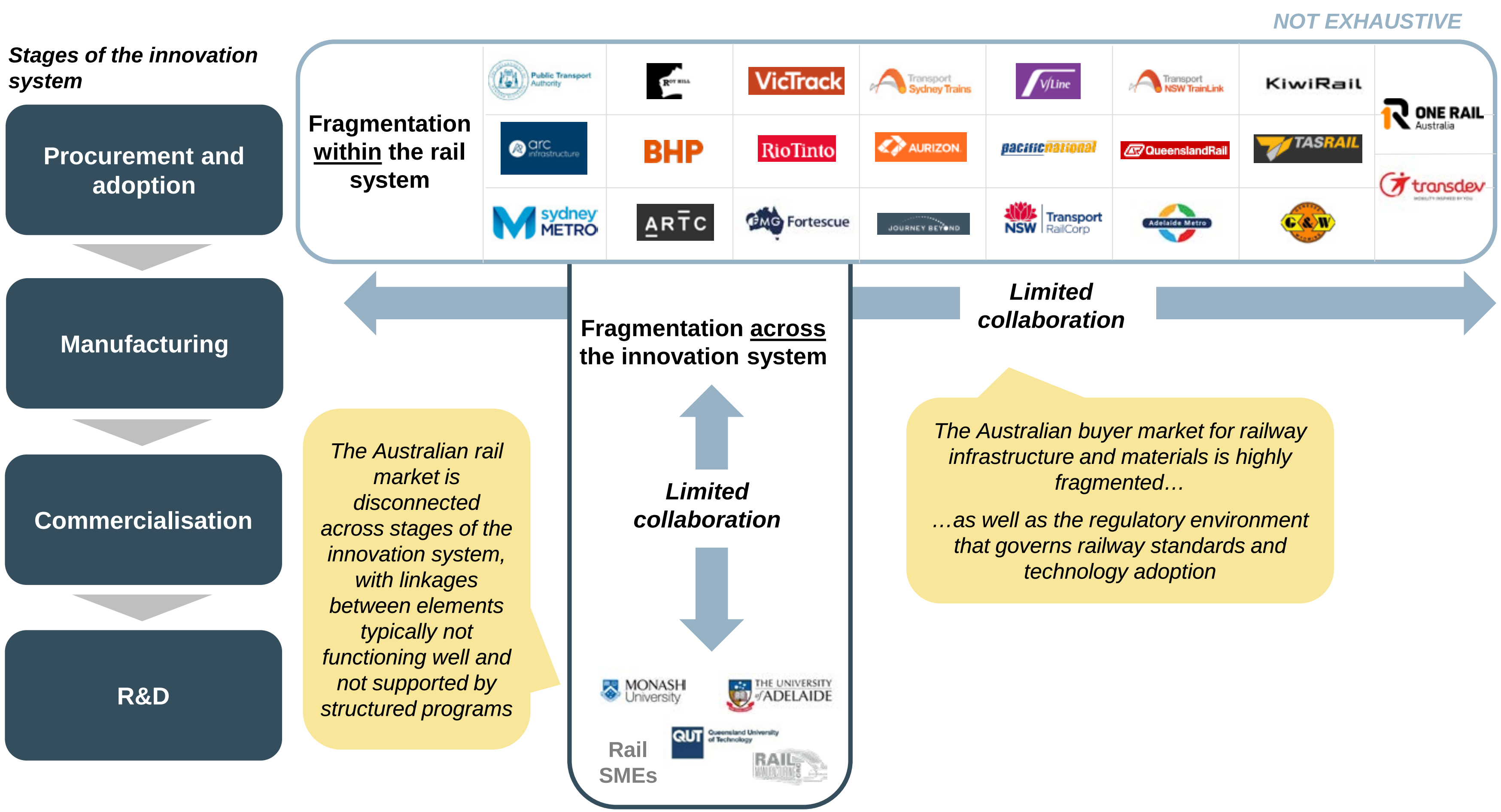
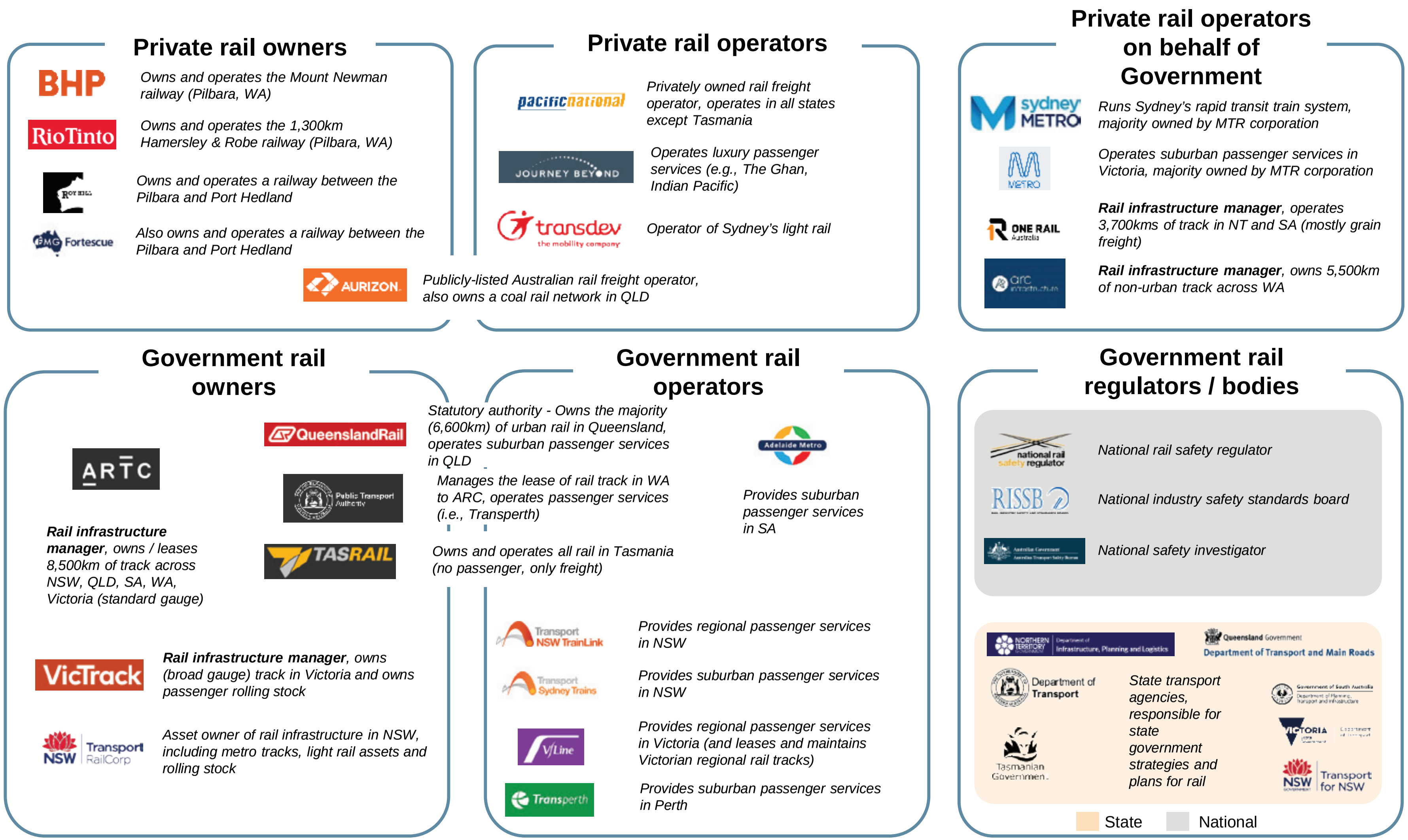


Figure 16: Illustration of fragmentation in the rail market



Source: Company and government websites; LinkedIn

The rationale for investment is also obscured by having multiple beneficiaries for any one upgrade. For example, the ARTC has established an industry working group to agree a commercial framework for shared investment in safety improvement through the ATMS system.

Fragmentation also causes duplication if adjoining sections of network infrastructure have different rail owners, with different state and national rules applying, and different standards intersecting.

> *"... In Australia, we have dozens of potential customers operating across freight and passenger and this is good that we can sell a single solution multiple times. But this is a double edged sword as there are different standards and approvals to consider...."*
>
> **Railway Technology Supplier**

The issue of poor interoperability in Australia's rail market is not new, but it is a deepening problem when it comes to new rail technology. The NRAP interoperability working group is dedicated to promoting interoperability through the implementation of new technologies

To date, Australia's various railway operators have implemented 10 different signalling technologies, so that one operator traversing a metropolitan network may find itself navigating multiple systems in a single journey.[56]

Looking ahead, this will worsen, as new projects under planning introduce significant variation around signalling and automation and rolling stock (Figure 17).

The Australian regulatory environment requires a supplier to navigate multiple standards and type approvals

In 2009, the Council of Australian Governments agreed to establish a National Rail Safety Regulator. In January 2013, the Office of the National Rail Safety Regulator (ONRSR) and the Rail Safety National Law (RSNL) was enacted in South Australia. Queensland was the final jurisdiction to sign on to national regulation, joining ONRSR in July 2017.

However, Australia's co-regulatory framework allows rail operators to adopt and administer their own standards, according to their safety management system and associated risk assessments. The framework, and the fact that standards are not mandated, allows operators to choose which standards to set or adopt for their network – or to author their own standards.

The key requirement for operators under the co-regulatory model is to ensure their unique operating environment is taken into account.

This results in different standards being adopted and implemented across Australia's rail operators.

Despite efforts to set national rail standards through the Rail Industry Safety and Standards Board (RISSB), national standards only cover a small proportion of state-based standards. Rail operators also often interpret RISSB's standards differently, and are under no obligation to adopt them.

Sydney's inner city network, Tasmania's freight rail service and a mining railway in the Pilbara have significantly different operational requirements, and therefore require different standards. However, networks with similar requirements, for example Sydney and Melbourne Metro networks, do not have aligned standards.

On one hand, this implies that there is 'flex' in the system for innovative companies and railway operators who are willing to invest the time to work with regulators. Nonetheless, its downside is apparent. Industry suppliers pointed to the strong tendency of Australian railways to prefer bespoke solutions, rather than go through the pain of 'collaborating', or pooling R&D resources in the pursuit of new technologies. This suggests that state-based procurement processes can in practice be barriers to national efficiency.

Type approvals also require new technologies to pass through discrete operator testing prior to being adopted by railway operators. In Australia, new technology must pass through each railway operator's specific approval process prior to being rolled out, regardless of whether the technology has been approved elsewhere. Type approval with one operator does not serve as a 'trust marker' to another rail operator. This adds a further hurdle to those that are developing innovative technology.

> **The multiple standard and type approvals leads to technologies being implemented inconsistently across Australia**
>
> *"... We have half a dozen RTOs with their own type approval processes and standards and ideas as to how their railway should function and operate ..."*
>
> **ARA Technology Discussion Interview**

Figure 17: Example of fragmentation in the forward pipeline for rail investment

		Cross River Rail	Inland Rail	Metro Tunnel (Victoria)	Sydney Metro (NSW)	METRONET (WA)
Project overview	**Funding**	$5.4bn	$10.7bn	$11bn	$16.8bn	$4.1bn
	Responsible entity	Cross River Rail Delivery Authority	ARTC	Rail Projects Victoria	TfNSW	Public Transport Authority, WA
	Description	Two twin 5.9km underground rail tunnels, providing a second river crossing for rail through central Brisbane	A 1,700km freight corridor connecting Victoria, NSW and Queensland	Two twin 9km rail tunnels & five underground stations in Melbourne's CBD to increase capacity	A fully automated rapid transit system to increase capacity Metro NW is open, others under construction	An expansion of the metropolitan Perth network ***Trains must establish connection with control centre before entering each jurisdiction (not interoperable)***
Project specifications	**Control centre**	Queensland Rail's Rail Management Centre	ARTC Network Control Centre	Sunshine and Dandenong Control Centres	Control centre at Tallawong Station	Control centre in Perth for Transperth services
	Gauge	Narrow (as per the rest of Queensland)	Standard (Dual standard / narrow gauge in appropriate QLD sections)	Broad (as per the rest of Victoria)	Standard (as per the rest of NSW)	Narrow (WA has c.40% narrow and c.60% standard gauges)
	Signalling	ETCS L2 (European Train Control System)	ATMS (Advanced Train Management System)	HCS (High Capacity Signalling – a type of CBTC)	ETCS L2 (European Train Control System)	HCS (High Capacity Signalling – a type of CBTC)
	Automation*	ATO (GoA2)	None	ATO (GoA2)	ATO (GoA4)	Planning for ATO, but not yet approved
	Rolling stock	75 New generation rolling stock (NGR), manufactured in India between 2014-2019, QLD govt paid $4.4bn, **100% local content required for future maintenance & repair**	Private above rail operators can use **existing** rolling stock, because Inland Rail will have interoperable gauge with the rest of the national freight rail network	65 new High Capacity Metro Trains (HCMT), commissioned by the DOT in 2016, subject to **local content level of 60%** for the fleet	Alstom will build 23 new driverless trains **in their Indian facility**, on top of the 22 driverless trains already in operation on the NW Metro	246 new railcars by 2022 for $1.2bn, subject **to 50% local content requirement** Lifting jacks, bogie press and bogie turntables are locally built
	Local Provider	Qtectic consortium (led by Bombardier) provides final assembly and maintenance in QLD	None	Evolution Rail (a consortium of Plenery, Downer and CRRC) manufactures in Victoria	None	Alstom manufactures in Bellevue, WA

Notes: *Degree of automation is measured by Grade of Automation (GoA). GoA2 means the driver operates the doors and handles emergencies with automated starting and stopping, while GoA4 refers to a fully automated driverless system

4.2 Funding certainty and support is lacking for rail R&D and commercialisation

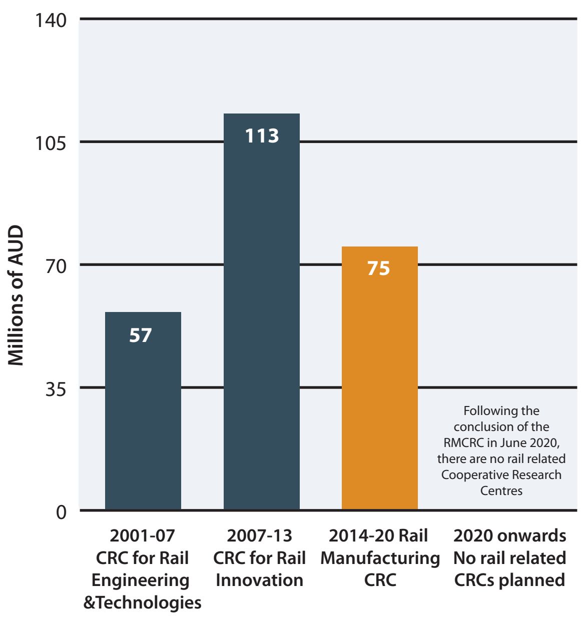
Government support for commercialisation has tended to be on a periodic, programmed basis – with CRC funding recently concluding

Government program funding of Australia's three rail-related CRCs was established with a predetermined end date, and no commitment to continued investment after the initial funding period.

Industry participants believe this lack of continuity in rail research has broken the momentum of the R&D culture that the RM CRC had begun to build within the industry. The latest CRC finished in June 2020 with no future plans for a federally funded rail R&D institute.[57]

While there continue to be mixed views about the relative successes of the rail CRCs, the focus has tended to be on whether the RM CRC met its original objectives in full, with smaller suppliers in particular noting the importance of a centre that could connect researchers and small innovative companies with larger suppliers and project funders. Overall, the finite tenure of the CRCs, and continuous change to the collaboration models utilised, are contributors to uncertainty.

Figure 18: CRC funding (2007-2020)



Source: Rail Manufacturing CRC Annual Reports 2014-2019, The CRC for Rail Innovation legacy, L.E.K. Research and Analysis

In the UK, investment and funding programs for rail innovation have been able to build upon the institutional set up of UKRRIN, Innovate UK and Catapult programs. The UK Government established a wider target of 2.4% of GDP investment in R&D by 2027, with rail R&D an integral part of its Industrial Strategy.[58]

Figure 18 shows the funding periods for the Cooperative Research Centre for Rail Engineering and Technology, the Cooperative Research Centre for Rail Innovation (CRCRI) and the RM CRC. Over the course of the RM CRC's funding period, it received c.$75m, of which c$46m was from government and c.$29m from industry.[59]

> *"...As the CRC got moving, the industry developed a better R&D culture. Just when industry became interested in how to partner with a university and the CRC, the CRC stopped – which is a pity as it started to build momentum...."*
>
> **Railway technology supplier**

Past reviews of the Australian innovation system have identified the clear need for public support in supporting the translation of ideas and research to commercialisation. During the 2014 Parliamentary Inquiry, the CSIRO explained a period of scaling up, where an innovator faces significant costs but minimal revenue opportunities as the 'valley of death'.[60]

The Australian Defence Innovation Hub and UK Rail Research and Innovation Network receive government funding to stimulate innovation, both of which are regarded as being successful. The structure of these institutes is summarised below.

CASE STUDY:

Alternate models of funding innovation. The Defence Innovation Hub (DIH):

- The DIH provides opportunities for research institutes and businesses of any size to put forward innovative proposals that enhance the defence capability
- Accepts proposals across the spectrum of the innovation system, from concept evaluation to prototyping and capability demonstration
- The DIH can provide collaboration through a subcontracting arrangement with universities and research institutes[61]

4.3 Cooperation is weak between innovators and industry

The Australian market is disconnected across stages of the innovation system

Generally, while Australia's research sector is strong, its levels of collaboration and commercialisation are poor – and this is evident in rail innovation also.

Industry participants advocate for measures to bridge the 'gap' in the innovation ecosystem between R&D and commercialisation.

This review identified that the various paths to market require close cooperation and financial flows between developers and end users, requiring significant effort (and risk) to find the 'right match':

- A SME undertakes research or development then self-funds or seeks a capable investor for productisation
- A rail operator enters a partnership with a large rail technology group or supplier
- A research entity is funded by, or partners with, a rail manufacturer, through a forward order or a research grant

One supplier noted that venture capital was scarce for rail innovation projects, even more so in Australia.

Major pipelines of procurement can also underwrite commercialisation. For example, the program of Waratah rolling stock procurement underwrote the local development of improved on-board technology that benefited subsequent rail projects.

Alternatively, vertically integrated railways in Australia (for example Rio Tinto) undertake their own R&D and commercialisation activities.

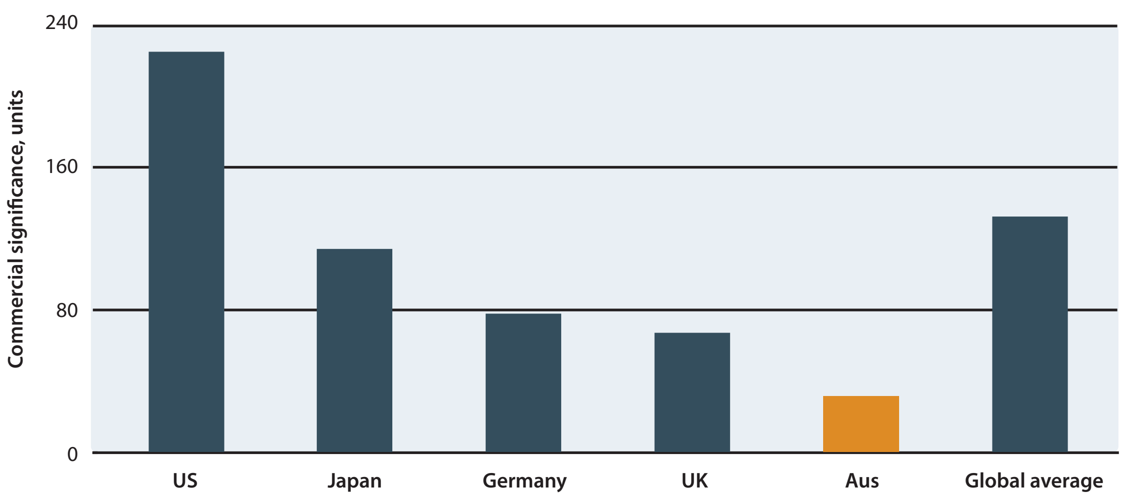
Globally, government-run programs better connect industry with innovators. European models such as Shift2Rail embed Original Equipment Manufacturers within the research planning process.[62]

The Australian rail patents data offers insights into the relative difficulty of rail technology commercialisation in Australia.

Figure 19 shows that in general, Australian-originated rail patents attain a lower level of commercial significance than those that originate overseas. This measure of 'commercial significance' gives an indication of the likelihood that a patent will be widely applied internationally, based on the number of other countries the patent is taken in, whether it is renewed, and has forward citations.

> *"... There is no real mechanism for the commercialisation of R&D. The SMEs have good ideas, but no cash or means of distribution, the large companies have the cash but no long term outlook. An initiative to bring them together would achieve the best outcomes ..."*
>
> **Railway technology supplier**

Figure 19: International patent commercial significance across benchmarked jurisdictions



Source: The Patent Searcher database, L.E.K. Research and Analysis

4.4 State-level local content requirements inhibit manufacturing scale

State government procurement policies often stipulate a minimum level of local content required within rail projects.

This results in suppliers having to establish small-scale, duplicative facilities for the same platform or product in multiple sites around Australia, rather than building scaled, specialised manufacturing facilities.

Australian states have individual local requirements that manufacturers must adhere to. For example;

- Victorian Government policy aims to ensure a minimum 50% local manufacturing content requirement will be applied to the procurement of transport related products and services. The government has stated that it will view the greater proportion of local content more favourably in selecting tenders [63]
- Queensland's procurement policy, 'Buy Queensland', places priority on proximity of the workforce to where the goods and services are to be provided, with those within 125km being given precedence.[64] Industry has identified that the concept of concentric circles of local content is descaling the industry within Queensland itself

Western Australia has introduced a new Buy Local Policy 2020 for all state government procurement which supports local manufacturing and SME participation

The reduced scale resulting from state-based local content requirements reduces the efficiency of Australian manufacturing and assembly operations.

"...State based local content drives costs up and makes it more complicated for local procurement. It ends up de-scaling the industry, when there's no collaboration encouraged between states..."

Railway consultant

Industry participants have expressed frustration at the local content requirements:

"There is a case for stupidity as we get caught up in local content. The local content requirements were so stupidly onerous that they were struggling to get the tender met. These require a proportion of local profits, the employment of indigenous people, employment of local people, and involvement of local businesses."

Railway technology supplier

"States are increasing the amount of local content required in their procurement policies. States are going about manufacturing things differently, this is crazy as it splinters down the capability and efficiency of doing local manufacturing. We have been spruiking government to create some federal leadership about how we move to local manufacturing."

Railway technology supplier

"...state based content resulted in having to manufacture bogies in [the state's capital city]... our factory was in [another state]...we had to use a supplier who has never built bogies."

Railway consultant

4.5 A risk averse rail culture which avoids experimentation

A risk averse culture within Australia's passenger rail sector was consistently cited by industry stakeholders as a barrier to adopting new technologies, enforced by weak managerial disciplines to change management.

Private sector approaches to evaluating the risk-return basis for new investment was conversely identified as cultural enabler of technology adoption. Australia's private sector rail owners and operators see clear financial benefits in managing technology adoption risks rather than choosing to eliminate all risk by not adopting new technologies.

Five primary types of cultural risk aversion were identified and are outlined below.

In citing safety risks as contributing to a risk averse culture within the railway industry, it is recognised that while this is currently a barrier, there is significant scope for rail technology and innovation to improve safety. As such, innovators should as much as possible highlight the improved safety outcomes of new technologies to help accelerate their adoption.

> *"...The leaders in the business need to be able to accept risk, we were really clear with the board and safety regulator: these are our risks and these are how we are going to manage and mitigate the risks..."*
> **Railway operator**
>
> *"...If BHP can sniff an extra dollar through tech adoption, they will pursue it..."*
> **Railway technology supplier**

Table 1: Risks identified by industry as barriers to technology adoption

Risk type	Description	Quotes from consultations
Product performance risk	Australia's public sector rail operators require an extremely high evidence base that demonstrates product performance	*"...Government has no risk appetite at all, a tender "must be able to demonstrate usage or application somewhere else in the world for 5+, 10+ years..."* **Railway technology supplier** *"... The biggest obstacle is culture in Australia. We ask 'What are the issues and problems of initiating new technology?' In Hong Kong they have a constructive attitude that asks 'How do we make this work?' ..."* **Railway service provider**
Liability risk	Responsibility for meeting standards often sits with Chief Engineers, with personal liability if an accident occurs	*"...Public railways are run by chief engineers – they are not looking for new tech, they are looking for the keeping the railway out of the newspaper...Introducing new tech brings in new risks, they are not keen to look at the long term commercial efficiencies...."* ***Railway supplier***
Political and reputational risk	There is greater political and reputational risk for the late delivery of rail projects, than the failure to implement world leading technologies	*"...There is so much risk in a big project ministers have gotten into more trouble from late delivery and poor delivery than the kudos they get for new technology..."* **Railway technology supplier**
Safety risk	Railways are dangerous operating environments. Railway operators need strong comfort levels that new technologies are safe before adopting	*"...Any serious innovations need to be really clear on safety regulations... people want the safety case to be presented first..."* **Railway operator**

4.6 Public sector procurement mechanisms do not properly assess whole of lifecycle costs

Industry consultations highlighted the role of public sector procurement and contracting in enabling technology adoption and promoting supplier-led innovation. The appetite for innovation can be hampered on large capital projects that have an upfront cost control imperative, where contracts manage for risk by requiring 'established' solutions that have been used elsewhere, or where network improvements are deprioritised against new capital projects in the electoral cycle.

1. Public sector procurement does not incentivise the development of projects with high upfront capital costs even where these achieve operational savings

Public sector procurement typically places greater emphasis on the immediate capital expense rather than whole-of-life costs. This prevents the procurement of technologies that drive long term efficiencies, but have higher capital costs.

> *"...The public-private divide is clear. Private operators look at total cost of ownership. Public authorities only look at capex, and not interested in the whole of life OPEX. They are not interested in introducing new tech that has lower cost of operation but costs higher CAPEX..."*
>
> **Railway supplier**

2. Procurement is prescriptive with limited mechanisms to incentivise innovation

Public sector procurement processes are typically very prescriptive with technical specifications and often do not include specific innovation KPIs. This leads to new technologies being excluded from the procurement process that do not meet the proscriptive specification.

> *"...The cross river rail project has no innovation KPIs..."*
>
> **ARA working group**
>
> *"... The government also writes very prescriptive tenders, because they are driven by bureaucracy. Government is a problem, they put in place a lot of procurement barriers to new or local technologies..."*
>
> **Railway technology supplier**

3. Business as usual procurement focuses on like-for-like replacement

Often, procurement is conducted with a mindset that specifically excludes new technologies, with specification of like-for-like replacement.

> *"...a lot of the business as usual procurement is done on a 'like-for-like' basis and does not consider new technologies..."*
>
> *ARA working group "...there is no motivation to change, as it's too much work for the individuals involved..."*
>
> **ARA working group**

The reluctance by states to involve the private sector in running transport operations and maintenance was also identified, with relatively short contract periods of 7-10 years seen as sub-optimal for long term innovation.

5 Opportunities for Australian innovation

In the next decade, Australia will see significant rail development, with $155bn in rail construction activity forecast over the next 15 years to 2035 – and 88% of that amount funded by the public sector. Activity in the next five years will be more than double the construction activity done in the past five years to 2020.[65]

Australia has a narrow window of time to ensure that planning and procurement across the national pipeline is technologically efficient, and maximises opportunities for Australian innovation and industry.

Three areas of timely focus include fostering Australian innovation that serves its unique operating environment, promoting Australian innovation on Australian projects and overseas, and supporting Australian manufacturing and local supply chains to adjust to the COVID-19 pandemic.

Figure 20: Summary of the opportunities to innovation within the Australian rail sector

Opportunities for greater innovation

↓

1. Australia's unique operating environment can spur innovation
2. COVID-19 highlights the importance of resilient and flexible local supply chains, and the opportunity for Australian innovation to play a role
3. Australia has pockets of innovation that could be promoted locally and abroad (*e.g. Pilbara, condition monitoring*)

Source: L.E.K. Research and Analysis, L.E.K. Interviews

5.1 Australia's unique operating environment can spur innovation

The Australian railway industry has in the past developed innovative solutions in response to Australia's unique challenges of high temperatures, expansive low-density rail networks, and constrained budgets. The need for far greater cost and energy efficiency on rail networks is an area where Australia could excel.

Australia has developed low cost signalling solutions that meet its unique freight network needs.

The ARTC required a signalling system for their 8,500km freight network.[66] Traditional signalling systems such as ETCS did not suit the ARTC's unique operating environment and was a high cost solution for the ARTC's network size.

ARTC developed ATMS in collaboration with Lockheed Martin, a first of its kind technology.
The ATMS is an alternative signalling system that is better suited to a long distance freight environment as it does not rely on expensive infrastructure that alternative systems require.[67]

ATMS provides an affordable solution that is better suited to ARTC's operating environment.

"... The cost of developing ETCS for our track would have been worth more than the book value of the business ... the business isn't suitable for ETCS; it was worth taking the risk of finding an alternative. ..."

Railway operator

Track stability management technology was developed to assist the management of hot weather induced rail compression stress.

Australia's extreme climate has driven innovation in the field of heat management. Compression stress in hot weather periods has historically caused rail to buckle. In 2010, A Queensland Rail heavy haul train was derailed due to compression stress causing delays to services, reputational impact on the business, and significant financial stress on Queensland Rail National Coal.[68]

Through testing undertaken in Queensland by the CRC for Rail Innovation, a Track Stability Management (TSM) tool was developed. The TSM tool includes new sensors and gauges on the railway that measure heat-related rail stress, which can be used to determine if speed restrictions are required on sections of track to maintain a safe operating environment.[69]

Industry participants that were consulted for this study identified major opportunity areas for Australian innovation which would also have critical market interest from abroad. These included rail solutions that improve climate resilience, energy security, and which deliver high-tech, low-cost innovations using big data, digitalisation and the internet of things.

CASE STUDY:

The UK's Rail Sector Deal

The UK Government and its supplier sector reached a landmark agreement named the Rail Sector Deal, designed to raise the national intensity of research and development and innovation across the rail sector, and provide industry certainty around investment.

The Deal works with Network Rail's commitment to invest £245 billion investment in research, development and innovation in rail infrastructure between 2019-2024, subject to third party investment, and targets innovation that will drive efficiency and productivity, as well as domestic industry competitiveness.

The agreement focuses on making government's digital investments more transparent, and working towards a whole system unit cost by the end of 2025 that is significantly lower than current UK conventional infrastructure-only costs. It also provides for major improvements to data sharing, education and skills, and greater opportunities for innovation in rail contracts.

5.2 COVID-19 is driving a review of local supply chain strategies, and Australian innovation can play a greater role

COVID-19 has influenced Australian public transport usage

Public transport usage fell significantly during the COVID-19 outbreak as government promoted "stay at home" messaging. Public transport rail usage in Queensland fell to 16% of usual volumes during April, with similar declines evident across the country.[70] This disruption has prompted the need for operators to innovate more rapidly, whether this be through changes to off-peak pricing to reduce peak loadings, or reconfiguring train carriages to accommodate social distancing.

New technology is also being applied to monitor passenger numbers on Sydney train carriages to help evenly distribute passengers (Sydney Trains displays real time carriage occupancy rates on platform screens, with passengers able to position themselves to board less congested carriages). These types of innovation will help provide the community with comfort around post COVID public rail travel, speeding up the return of passengers to the network.

COVID-19 has increased the rail industry's focus on being more self-reliant for critical supplies

Being more self-reliant for critical supplies is a precautionary measure in the instance where Australia cannot currently expect the same level of responsiveness from global supply chains to import equipment and technology.

A recent survey of the rail industry identified 91% of respondents felt COVID-19 had impacted their business, with 68% reporting international supply chain issues with production, delivery or service offerings.

Rail operators reported that the delivery and price of rail goods has also been impacted, with equipment from international suppliers delayed as a result of COVID-19. Australian rail companies have reported some price increases and delays extending to 2021 for critical equipment.

COVID-19 has also highlighted the benefits of a productive and efficient local supply chain.

During the COVID-19 pandemic, the importance of rail freight was recognised by governments, and was declared an essential service. In increasingly uncertain times, having a reliable local supply chain is becoming more and more important.

Adopting innovation and technology that makes rail freight a more productive part of our local supply chain increases overall supply chain resilience and ensures goods and services get to where they need. Whilst the importance of a resilient supply chain has been acutely highlighted during COVID-19, supply chain resilience is also needed to respond to climate change driven extreme weather events (for example increased instances of flooding and bushfires), which will continue to challenge Australia's existing freight rail networks.

> *"... The ability to 3D-print unique products for customers in real time...has been providing huge opportunity for competition in the domestic market..."*
> **David Chuter, CEO of IMCRC** [71]
>
> *"... There's actually a new opportunity because of knock-on impacts of COVID-19. I see an opportunity in Australia for specialist new products – no reason why not ..."*
> **Railway consultant**

> *"... Post COVID, there has been conversations about increasing the proportion of local content. The question is; "What is the local content?" as the machine manufacturing is not going to come back unless we embrace more innovative manufacturing technologies ..."*
> **Railway technology supplier**

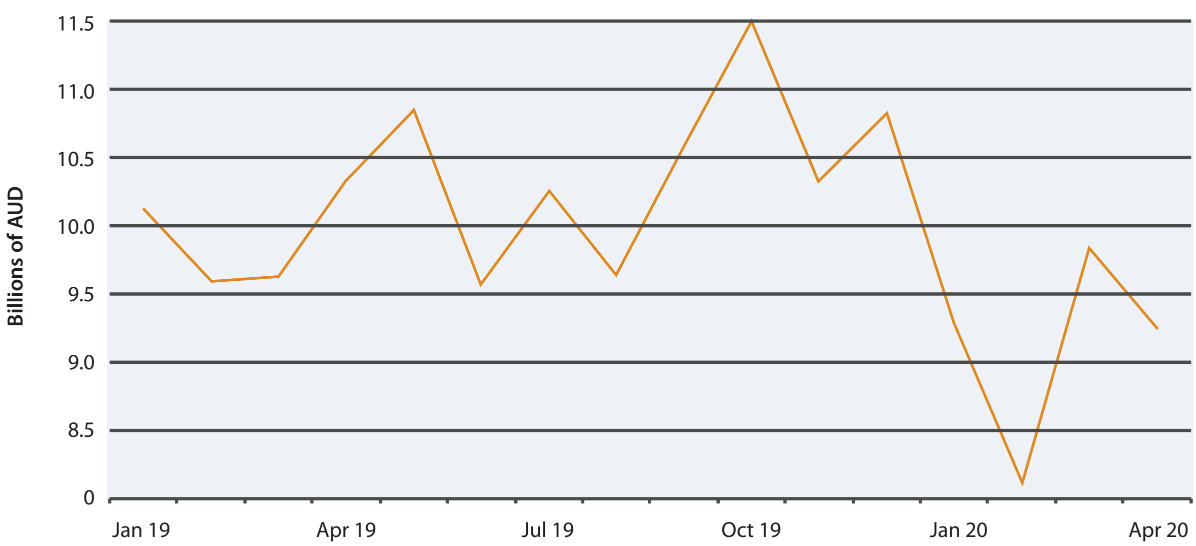
COVID-19 may prompt a shift towards onshoring and other manufacturing alternatives

COVID-19's disruption is prompting governments to rethink measures for supporting sovereign manufacturing capability for strategic and high value products.

A starting point for this may need to consider Australia's manufacturing strengths which increasingly tend towards higher value, high tech manufacturing activities, while less complex manufacturing has been shifted abroad.[72]

Industry participants have identified that there would likely be demand for locally manufactured rail equipment that can be delivered more reliably and more quickly. In the absence of this certainty, some cited that they had had to increase their inventory stock levels to insulate their exposure to disrupted global supply chains.

Figure 21: Australian import of machinery and transport equipment



Source: Australian Bureau of Statistics, L.E.K. Research and Analysis

5.3 Australian innovation could be better promoted locally and abroad

Australia has pockets of global best-in-class innovation. These include the world's most advanced heavy haul railways operating in the Pilbara region, and world class research organisations such as the MIRT that have developed cutting edge rail technologies that have been adopted abroad.

For example, MIRT has developed a best in class condition monitoring system and is considered a world leader in condition monitoring technology. The system monitors the condition of the railway in real time as the trains operate their normal service, creating greater efficiency in railway performance, passenger safety, comfort, and extends the life of the rail infrastructure.

In 2017, MIRT's condition monitoring technology was implemented by the Hong Kong metro – a railway that supports 5.4million passengers every week.[73] MIRT's condition monitoring technology has also been adopted by heavy haul miners, Rio Tinto and BHP.[74]

Major state governments are also initiating programs of investment attraction for advanced manufacturing, and initiating procurement programs for new rail and road technologies, which could improve the pool of partners for Australian rail innovation.

Trade and investment promotion for Australian rail innovation would have the potential to develop new products, expand existing products into new markets, and attract new partners to collaborate with Australian firms and institutes. Supporting local applications of Australian innovation can also provide support for its use and success globally.

CASE STUDY:

Success within Australian rail R&D

- Rio Tinto and Fortescue Metals Group (FMG) own extensive private railway networks used for transporting coal and iron ore from mine to ports. These private rail operators have a strong incentive to innovate where it yields cost efficiencies and safety improvement. As a result, private miners can see significant benefit investing in in-house R&D programs to support new technologies.
- FMG owns and operates the fastest heavy haul railway network in the world. Furthermore FMG's railways have 40 tonne axle loads, making it the heaviest haul railway in the world.[75]
- In 2019, FMG established an R&D centre in Karratha for research into autonomous mobility.[76]
- Rio Tinto developed Autohaul, the world's first autonomous heavy haul long distance rail network in collaboration with Hitachi Rail S.T.S which was launched in 2019.[77]
- Autohaul has improved operational flexibility, by removing the need to match up trains and drivers. Autohaul has achieved a 6% speed improvement over manned trains.[78]
- Data collection from Autohaul will enable Rio Tinto to use predictive analysis to better target maintenance.[79]

RioTinto

FMG Fortescue The New Force in Iron Ore

6 A new compact for Australian rail innovation

The future of rail innovation in Australia requires a single-minded focus on national productivity, with a multi-pronged approach to driving collaboration and building a culture for innovation and continuous improvement. This recognises the 'virtuous circle' between collaborative rail research and innovative and cost-efficient railways.

A compact that fosters the contribution of Australian research and industry, and provides strategic alignment between governments, while delivering unprecedented rail investment over the next 10-15 years, will dramatically boost the economic legacy of planned investments. It will build on the findings in *On Track to 2040*, embedding its strategic and technological priorities for the Australian rail supply industry.

The compact will have three objectives: to make rail innovation a national priority; to develop a single market for rail technology; and to build a culture for rail innovation. Importantly, the ARA will take a leading role in advocacy and engagement for this compact, in consultation with Australian governments and businesses.

6.1 Objective 1: Make rail innovation a national priority

National recognition of the importance of rail technology and innovation will drive the productivity and performance of the national land transport network, while fostering higher value added local industries.

Public champions for rail innovation and sustained leadership and investment are needed to drive collaboration, commercialise innovation, and support procurement and adoption that improves safety, energy efficiency and rail productivity.

1a. Establish a new national public body for rail innovation

A permanent national public body for rail innovation to drive interoperability across Australia's pipeline of projects, bring to rail the best from across digital technology fields (e.g. defence, telecommunications, mining and energy), and drive a national agenda for world leading rail innovation promoting safety, sustainability and efficiency.

The body would function as a national centre of excellence that drives strategic and long-term partnerships for rail R&D and builds links to other sectors where there is potential for relevant cross-sector learning. This would include fostering the national rail innovation system and enabling collaboration between smaller innovators and larger manufacturing bodies and rail operators.

In establishing the new body, major stakeholders would need to be consulted, including ACRI, major universities, operators, RISSB and suppliers.

Some first deliverables for the new body are established in Actions 1b-1d.

1b. Establish an investment program to initiate and commercialise rail R&D:

Consistent funding for R&D that is aligned to the needs of industry (possibly using a model involving industry matched funding)

1c. Develop a national rail innovation and capability strategy:

A plan for industry capability and skills development that is aligned to jurisdictions' future digital investments pipeline. As a first step, the strategy needs to ensure that innovation is a central component of the NRAP, and the recommendations in this report are included in the next iteration of the Plan.

1d. Develop an exports strategy for Australian rail innovation:

The strategy would be aimed at promoting the Australia rail innovation sector, leveraging trade missions and international events to target high value and exportable rail innovation.

The benefits of these initiatives include better alignment of rail supply chain participants, more effective assistance for Australian firms to access global rail customers, investment and capability that improves systemic fragmentation, and spill over to jobs and industry capability, drawing the best learnings available from other sectors.

6.2 Objective 2: Develop a single market for rail technology

A single market with common standards for rail technology would support an innovative rail sector in Australia. It will promote scale efficiencies, support supplier specialisation and local manufacturing, and encourage 'pull-through' in the innovation system from research to productisation.

2a. Transition towards common standards, linked to nationally accredited testing

Australia should set a priority of moving towards a single set of national standards where feasible, supported by common type approval processes that address unnecessary regulatory fragmentation and which streamline the path to market for new technology.

The benefits will be both to procurers and providers of new technology. Greater consistency by buyers would achieve improved economies of scale, lower costs and lower barriers to adoption.

A common approvals process could be supported by a new national testing facility (see for example the Transportation Technology Centre in America[80]) or a national network of testing facilities to remove unnecessary duplication of approval requirements and work with RISSB on agreed standards.

Developing consistent adoption of standards and type approval processes should continue to be a priority that is advocated for in the Australian National Rail Action Plan.

2b. Advocate for the replacement of state local content policies with a national policy

While it is recognised that there are important strategic and workforce objectives built in to local content policies, inefficiencies can be inadvertently created with the application of state based local content policies that limit investment, growth, competitiveness and innovation for local suppliers.

2c. Develop industry-standardised training for new rail systems

As common standards and testing across Australia is developed, the development of training and skills programs for rail staff will be needed.

6.3 Objective 3: To build a culture for rail innovation

A culture that supports rail innovation must start with rail network planners, transport executives and Ministers. And it should flow through from the planning of investments and post-build improvements to agency-level procurement and contracting.

3a. Focus on best practice procurement and contracting

Best practice procurement and contracting mechanisms by public sector agencies have the potential to accelerate technology adoption. Mechanisms that are effective include innovation targets and incentives for rail contractors and operators, and removing terms that discourage the procurement of like-for-like replacement of components where newer technologies are available.

Government procurement policies should also assess new products based on lowest total lifetime costs (capital and operational costs combined) rather than lowest up-front capital outlay.

The long-term benefits of these changes could be material, with the c.$155 billion pipeline of rail projects across Australia over the next 15 years providing significant opportunity for innovation.

3b. Develop states' smart rail strategies to build the planning pipeline for digital technology

Traditional rail planning remains skewed towards an engineering-dominated focus on physical infrastructure as the means of achieving safety and productivity improvement. Furthermore, *On Track to 2040* identified the uncertainty for suppliers of predicting demand for rail projects.

A commitment by states through the Transport and Infrastructure Council to develop state-based smart rail investment strategies would support a culture change within the rail sector, and improve planning transparency in ways that the supplier sector could prepare more efficiently for. These would be subsidiary plans to state-based infrastructure strategies, and would inform the National Rail Innovation and Capability Strategy (Action 1c).

The strategies would canvass both marquee projects and improvement projects that retrofit and augment existing networks. These strategies could be developed in conjunction with the new public body for rail innovation so there is an overarching vision and harmonisation between states.

Although the ARA's 2019 Smart Rail Route Map is a positive first step in providing a framework for generating higher levels of technology adoption, there remains inconsistency of Route Map adoption throughout the rail industry. An important way to embed national rail planning priorities in Australia is to ensure that these priorities *are* state priorities. This recognises the dominance of state rail planners in driving the pipeline of rail projects in Australia. Therefore, the state-based strategies could be considered the supporting 'route maps' if required.

3c. Build the brand for Australian rail innovators at global trade shows

Australia will need to build its brand around rail innovation, capturing past successes and cultivating opportunities for emerging innovators. The ARA and others host forums that support operators' engagement with the supply chain and with rail innovation businesses – which are a critical way to promote innovation. More strategic national positioning at international trade shows, such as the *InnoTrans* trade fair held in Berlin every two years, would foster local demand for innovation and expose Australian railway procurers to evolving rail technologies.

Figure 19: Strategic response and actions summary

Objectives		Actions
1. Make innovation a national priority	1A	Establish a new national public body for rail innovation
	1B	Establish an investment program to initiate and commercialise rail R&D
	1C	Develop a national rail innovation and capability strategy
	1D	Develop an exports strategy for Australian rail innovation
2. Develop a single market for rail technology	2A	Develop common standards, linked to nationally accredited testing
	2B	Advocate for the replacement of state local content policies with a national policy
	2C	Develop industry-standardised training for new rail systems
3. To build a culture for rail innovation	3A	Focus on best practice procurement and contracting
	3B	Develop states' smart rail strategies to build the planning pipeline for digital technology
	3C	Build the brand for Australian rail innovators at global trade shows

Source: L.E.K. Research and Analysis, L. E. K. Interviews

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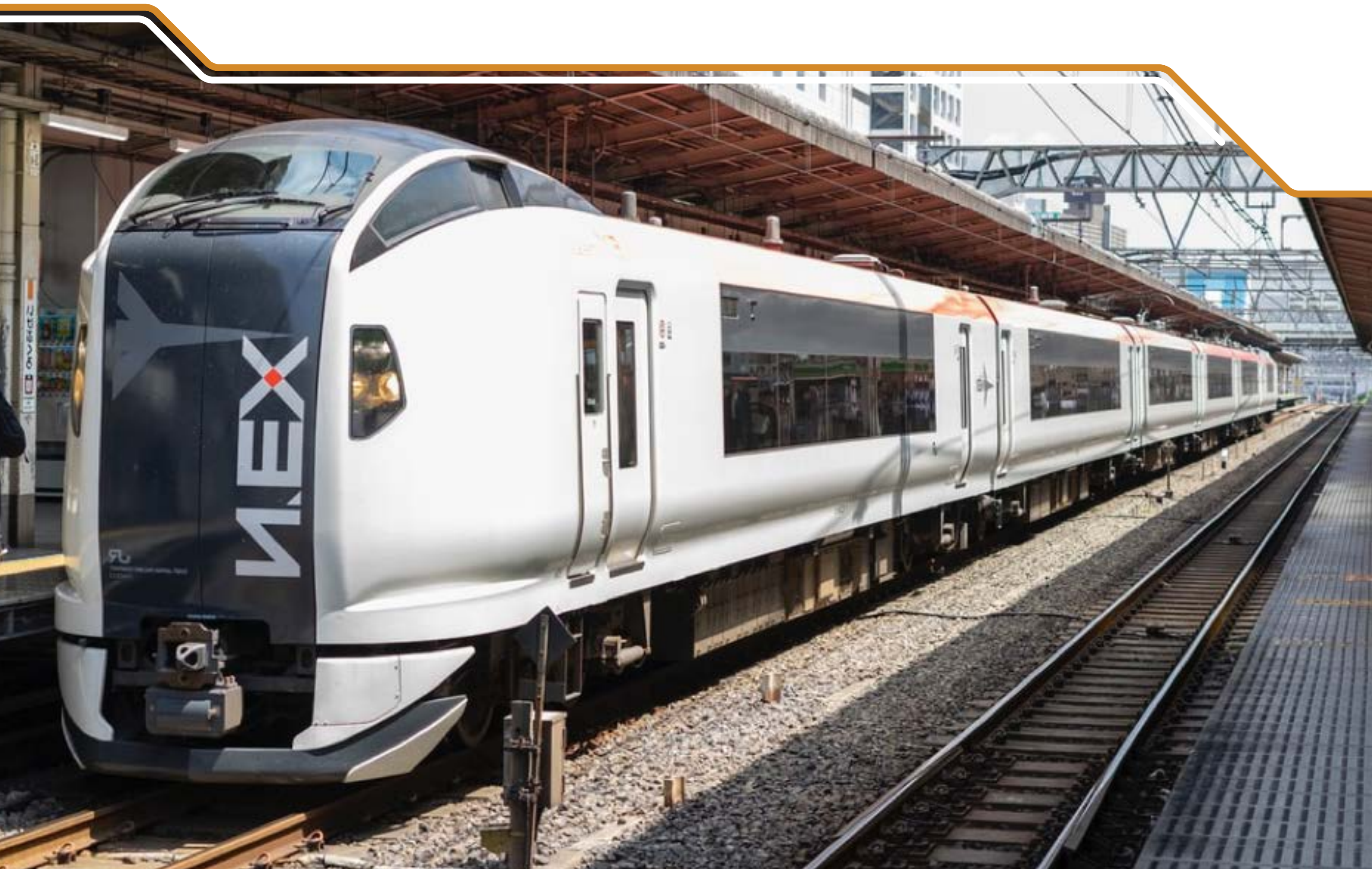

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Methodology

This research paper was developed using:

- Research and analysis of available rail and innovation literature
- Review of patents databases
- Development of case studies and research by L.E.K. analysts in other countries
- In-depth interviews with ARA members
- Consultation with industry advisory groups

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