GHD Advisory

Harmonisation of Rail Standards

Research Report

23rd October, 2024

→ The Power of Commitment

Commissioned by:

Australasian Railway Association

National Transport Commission
Leading change

Australian Government
Department of Industry, Science and Resources
Office of National Rail Industry Coordination

RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

Forewords

The Australasian Railway Association (ARA) advocates for a national approach to harmonising standards and greater interoperability to support an efficient, safe and productive industry. The fragmentation of rail presents a substantial challenge for both existing and prospective rail freight and passenger operators. Beyond suburban services, a considerable portion of trips in Australia require operation across two or more networks, each with varying standards, performance, access requirements and rule books.

Improved interoperability across Australian networks enables increased investment and economies of scale with more standardised rail componentry to support a safer and more innovative rail system. It would support a national approach to training and labour mobility in addition to facilitating rail's transition to net zero.

The harmonisation of standards is a key aspect to support interoperability of our national network, and the ARA is actively working with the National Transport Commission and state and federal governments to identify opportunities for reform. With the industry undergoing significant technological transformation, we risk a digital 'break of gauge' in our future rail systems, exacerbating existing challenges, if we do not act now.

The harmonisation of standards will enable the rail industry to reap the full benefits of the record $155 billion investment in public rail infrastructure over the next 15 years. By adopting a national approach to procurement, harmonising standards, and improving interoperability we will have a more efficient, competitive, innovative and safe rail industry, ensuring more value for taxpayers in government procurement outcomes.

This report outlines the case for a more effective approach, with supporting legislation, to facilitate industry's efforts to harmonise standards and fully realise the benefits this would enable.

Caroline Wilkie
Chief Executive Officer, Australasian Railway Association (ARA).

At the National Transport Commission, we work with all governments and industry to reduce differences across our transport networks, so they work better for people and the Australian economy.

Right now, the countless differences across individual rail networks are driving up the costs of running trains, upgrading networks and attracting skilled workers.

That's why National Cabinet has asked us to develop a National Rail Standards Framework that will help better connect our freight and passenger networks. It'll do this through a critical set of mandatory interoperability standards, as well as model standards to support national harmonisation of rail.

This work is delivering the most significant change to Australian rail since electrification. It's part of the National Rail Action Plan to make rail simpler, safer and better through consistent national approaches.

This report lifts our collective understanding of what is stopping rail from having a bigger role in the national economy and moving more people and products between cities, regions and ports.

With a $155 billion pipeline of investments to modernise and expand our rail networks, now is the time to bring networks together to create a single national rail system that works better for everyone.

Michael Hopkins
Chief Executive Officer and Commissioner, National Transport Commission (NTC).

Australian Government
Department of Industry, Science and Resources
Office of National Rail Industry Coordination

As the National Rail Manufacturing Advocate, I am pleased to introduce the *Harmonisation of Standards Research Report*, sponsored by ONRIC, ARA and RISSB, and authored by GHD.

Industry stakeholders have highlighted a range of barriers that stand in the way of achieving a more competitive and sustainable Australian rail manufacturing sector. This report lays out an important body of evidence supporting policy development to address these barriers.

I would like to thank the project co-owners for the collaborative spirit throughout the development of this report. I also thank stakeholders from across government and the rail industry for contributing to the development of these findings and insights.

Harmonisation of rail standards not only has the potential to advance interoperability and safety for Australian rail operations but is also an important measure to support the Australian rolling stock manufacturing industries. Harmonised design and manufacturing standards can enable suppliers to benefit from improved economies of scale, harness modern technologies and innovation and enable rail industry decarbonisation and the transition to net zero.

Adoption of harmonised standards is one of the central pillars of the Government's National Rail Procurement and Manufacturing Strategy. Harmonised standards can support a more competitive, efficient and sustainable domestic rail manufacturing sector. The evidence in the report and the recommended pathway options provide the foundation for further work in delivering the Strategy, alongside broader national rail reform under the National Rail Action Plan.

With continued collaboration we can enhance the interoperability, safety, efficiency, and sustainability of our national rail network, and provide a more sustainable business environment for the Australian rolling stock manufacturing industry.

Jacqui Walters
National Rail Manufacturing Advocate, on behalf of the Office of National Rail Industry Coordination (ONRIC)

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Since its inception more than 20 years ago, RISSB has proudly provided industry with good practice standards, codes of practice, guidelines and rules that deliver strong safety and efficiency outcomes for the rail industry. These products are vital for achieving nationwide safety and productivity improvements.

Recognising the imperative need for a cohesive and efficient rail network, industry must seek to establish and implement a concise set of high-impact interoperability standards. Having a clear understanding of barriers to adoption becomes a key step to implementation success and this report lays out the challenges.

The application of RISSB's standards enables Australian railways to move towards greater harmonisation and interoperability through improving efficiency in production, procurement, and personnel management, and delivering broader economic benefits. One of the harmonisation initiatives in this report highlights that a greater focus on the promotion and facilitation of the voluntary adoption and implementation of RISSB products, is an integral part of the solution.

In commending this research report to industry, I would like to acknowledge the outstanding work done by GHD Advisory to develop this important piece of work. We look forward to continuing to work with the ARA, NTC, ONRIC, and the wider rail industry, to create a better, more interoperable Australian rail network.

Damien White
Chief Executive Officer, Rail Industry Safety and Standards Board (RISSB).

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Scope and limitations

This report: has been prepared by GHD for ARA, NTC, ONRIC, and RISSB and may only be used and relied on by ARA, NTC, ONRIC, and RISSB for the purpose agreed between GHD and ARA, NTC, ONRIC, and RISSB.

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The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

Glossary of terms

Acronym	Full Form
AAR	Association of American Railroads
ACCI	Australian Chamber of Commerce and Industry
AMWU	Australian Manufacturing Workers Union
ANRP	Australian Network Rules and Procedures
ARA	Australasian Railway Association
ARTC	Australian Rail Track Corporation
ATMS	Advanced Train Management System
ATP	Automatic Train Protection
BITRE	Bureau of Infrastructure and Transport Research Economics
BS	British Standards
CBTC	Communications Based Train Control
COAG	Council of Australian Governments
DAE	Deloitte Access Economics
DIRN	Defined Interstate Rail Network
DISR	Department of Industry, Science and Resources
DTF	Department of Treasury and Finance (Victoria)
EBA	Electronic Block Authority
EN	European Standards
ERA	European Union Agency for Railways
EU	European Union
FMG	Fortescue Metals Group
GDP	Gross Domestic Product
GOS	Gross Operating Surplus
HR	Heavy Rail
HVNL	Heavy Vehicle National Law
ILM	Investment Logic Mapping

Acronym	Full Form
IMS	Investment Management Standard
IO	Input-Output
ISO	International Organization for Standardization
KPI	Key Performance Indicator
LR	Light Rail
MCA	Multi-Criteria Analysis
MoU	Memorandum of Understanding
MTM	Metro Trains Melbourne
NHVR	National Heavy Vehicle Regulator
NNI	National Network for Interoperability
NNTR	Notified National Technical Rules (in EU)
NPV	Net Present Value
NRAP	National Rail Action Plan
NRMP	National Rail Manufacturing Plan
NTC	National Transport Commission
ONRIC	Office of the National Rail Industry Coordinator
ONRSR	Office of the National Rail Safety Regulator
PC	Productivity Commission
PTA – WA	Public Transport Authority – Western Australia
PTC	Positive Train Control
QA	Quality Assurance
RIM	Rail Infrastructure Manager
RISSB	Rail Industry Safety and Standards Board
RSIA	Rail Safety Improvement Act (2008, in USA)
RSNL	Rail Safety National Law
RSO	Rolling Stock Operator
RSSB	Rail Safety and Standards Board (UK)
SERA	Single European Railway Area

Acronym	Full Form
SME	Subject Matter Expert
SMS	Safety Management Systems
SNCF	Société Nationale des Chemins de fer Français (France's national state-owned railway company)
TA	Type Approval
TSI	Technical Specification for Interoperability (in EU)
TfNSW	Transport for New South Wales
UIC	International Union of Railways
USA	United States of America

1. Executive Summary

1.1 The Rail Standards Harmonisation Problem

1.1.1 Context and Introduction

Largely because of its origin in separate State-based networks, Australia's rail network is not a singular system, but instead the composition of 29 distinct networks. It is large and complex, involving an estimated 197 accredited operators on approximately 51,100 kilometres of track. This fragmentation of the network can be problematic for existing or prospective rail freight and passenger operators to navigate given that, aside from suburban services, a significant proportion of trips in Australia involve operation across two or more networks, which often have varying standards, codes, and rule books, as well other key technical and operational characteristics.

In determining their rail standards, Rail Infrastructure Managers (RIMs) and Rolling Stock Operators (RSOs) participate in co-regulation under the Rail Safety National Law (RSNL). Under co-regulation and the RSNL, Australian governments do not directly prescribe, mandate, or otherwise enforce the specific standards under which RIMs and RSOs need to operate. Instead, the governments set a performance requirement for railways to operate safely, allowing the RIMs and RSOs to develop, review, and implement whatever standards they deem necessary to meet these requirements. The relevant regulator (ONRSR) only oversights that the standards that the RIMs and RSOs enact are compliant with the performance requirements in a nationally consistent way.

As a result of the co-regulatory regime under the RSNL across Australia, the nation's distinct networks are frequently subject to bespoke standards that govern only the systems, processes, and technologies on that network, which are often incompatible with systems, processes, and technologies of other networks. This can increase operational complexity for Australia's freight and passenger rail network, given that a decision made by one RIM can have implications for RSOs operating across multiple networks.

It is because of these dynamics in the Australian rail standards ecosystem, that Australia's Infrastructure and Transport Ministers and National Cabinet have tasked the National Transport Commission (NTC) with delivering the *National Rail Action Plan* (NRAP). The significant reform program is taking a national approach to rail in Australia by locking in critical standards and practices to improve rail's safety, productivity and efficiency, and boost competitiveness.

1.1.2 Project Purpose and Scope

Given the above context for Australia's rail standards ecosystem, this Project sought to gain deeper insights into what is preventing the adoption of existing International and Australian Standards, to achieve harmonised standards.

To this end, the Project sought to do the following:

- Undertake a desktop overview of the Australian rail standards ecosystem.
- Assess the advantages and disadvantages of harmonising rail standards.
- Quantify the benefits and costs of harmonising standards.
- Assess the barriers and risks to harmonising standards and identify opportunities to address these barriers.
- Undertake a categorisation of standards.
- Develop options for harmonising standards.

Ultimately, the strategic outcome of this Project was to assist in engaging industry in supporting the development of the National Standards Framework under the NTC's *National Rail Action Plan* (NRAP), as well as supporting the prioritisation of future work under ONRIC's *National Procurement and Manufacturing Plan*.

1.1.3 The Case for Standards Harmonisation

Several problems exist relating to the lack of standards harmonisation across Australia, which are associated with benefits to be achieved in a more harmonised future state. These problems and benefits from standards harmonisation relate to the following key areas:

- **Increased operational interoperability[1]:** Differing standards implemented by connected networks restrict the ability of the rail system to allow the seamless and unencumbered movement of trains across Australia, increasing costs, lowering efficiency and productivity, and impeding rail's modal competition.
- **'Economies of scale' for suppliers:** Differing standards fragment the market for common rolling stock components, increasing production and procurement costs, and impeding overseas market access.
- **More efficient Type Approval (TA) process:** Differing standards lead to bespoke and not mutually recognised TA processes, increasing costs, reducing efficiency, dampening competition, and creating uncertainty and delay.
- **Decarbonisation and transition to net zero:** Differing standards decrease the value proposition and competitiveness of rail freight relative to road freight, decreasing rail's mode share and leading to slowed progress towards achieving net zero CO2e emissions.
- **Improved safety:** Differing standards create complexity and opportunities for confusion, increasing safety risks for workers and rail users.
- **Greater technology adoption and innovation:** Differing standards mean development occurs in silos, so the rail sector is unable to harness network-scale benefits and efficiencies, reducing the extent of sector-wide innovation. It also discourages the market entry of existing technologies.
- **Lower training costs and increased labour mobility:** Differing standards mean that there are different skills and training requirements for workers across networks, creating inefficiencies, increasing training costs, and reducing labour mobility between networks.

1.1.4 Opportunities for Harmonisation

The benefits of rail standards harmonisation are becoming increasingly accepted by key industry stakeholders. As such, there are several factors currently at play, which together constitute a real opportunity and impetus for rail standards harmonisation in the short term. These include the following:

- **Favourable policy and strategic environment:** Several government planning and strategy documents have been produced, which are creating a policy atmosphere that is conducive to the introduction, acceptance, and implementation of significant change. These include the *National Rail Action Plan and the National Rail Manufacturing Plan and Strategy*.
- **Key stakeholder agreement and alignment:** There is formal stakeholder alignment acknowledging the issues posed by a lack of harmonised standards in key areas such as interoperability and manufacturing, including through a MoU[2]. This extent of agreement has not been seen previously.
- **Significant short-term infrastructure investment pipeline:** Over $155 billion is forecast to be invested in rail over the next 15 years. Given the magnitude of expenditure, even modest efficiency improvements resulting from appropriate standards harmonisation have the potential to generate significant during construction and ongoing operation.
- **Imminent technological advances:** New rail technologies associated with the rail network of the future will require the development of new and appropriate standards. This provides an impetus to proactively act on standards harmonisation, avoiding an extended 'lock-in' of non-interoperability.

1.1.5 Barriers to Harmonisation

Despite the opportunities for standards harmonisation, in Australia's voluntary rail standards regulatory environment, there are also several 'barriers' to why standards harmonisation has not occurred. These barriers include the following:

- **Minimal incentive to change:** RIMs are only incentivised to make network-level decisions that provide the best-perceived outcome for themselves and the customers within their jurisdiction. There is no financial, regulatory, legal, or other incentive to move towards unilateral alignment with a national standard. This represents a classic example of a 'collective action problem', where individual entities' discrete behaviours create barriers to achieving a collectively beneficial outcome.
- **Lack of information sharing and collaboration:** RIMs and RSOs are without a readily available and low-cost way of understanding the standards used in even an adjoining network. There are also limited opportunities for formal, structured, and accountable collaboration on rail standards harmonisation across the sector.

1 Interoperability is defined in Section 3 of RISSB's AS 7450:2013 standard as meaning "the ability of a process, system or a product to work with other processes, systems or products".

2 National Transport Commission (NTC). Memorandum of Cooperation to support National Rail System Interoperability for future major rail investments. NTC, 2023.

- **Path dependency[3]:** The initial path taken by State agencies and RIMs during the 19th and early 20th centuries has created entrenched legacy systems, which often lack compatibility with each other, making standards integration and interoperability more difficult.
- **Nature of voluntary national (RISSB) standards:** RISSB's approach to national standard development is driven by RIMs, who are not sufficiently incentivised towards standards harmonisation. As such, it has not been highly strategic or necessarily conducive to achieving interoperability or other standards harmonisation-related benefits. Additionally, some RISSB standards are minimally prescriptive, meaning RIMs tailor these standards to optimise outcomes for their jurisdictions, which does not necessarily consider alignment with other networks.
- **Network operating differences:** The Australian rail network has diverse operating conditions. This diversity means that different networks have different standards, especially infrastructure standards, which cause complexity in standards development when trying to achieve interoperability. Different commercial settings also impact preferences for standards that align with commercial imperatives.
- **Compliance costs and commercial pressures**: There is an inherent cost associated with changes in standards. This is because changes in standards could require RIMs and RSOs to materially change their assets, equipment, and practices to migrate towards compliance with a new, national standard.
- **Risk adverse culture:** RIMs are often risk averse, preferring to maintain the status quo rather than undertake changes that could disrupt their operations or incur unforeseen risks, safety concerns, or costs. The perceived risks associated with harmonisation, such as the potential increased safety liabilities, make RIMs hesitant to commit to collective efforts.

1.2 The Rail Standards Harmonisation Solution

1.2.1 Harmonisation Initiatives

Given the identified benefits, opportunities, and barriers of rail standards harmonisation, a list of 12 strategic initiatives has been considered. These initiatives were informed by a combination of stakeholder input and engagement, previous reviews, and research.

The 12 initiatives considered are as follows:

1. Greater government and industry alignment and promotion of voluntary adoption and implementation.
2. Establish a central directory or database for high benefit standards.
3. Greater harmonisation-specific stakeholder collaboration forums and technical working groups.
4. Incentive programs for early harmonised standards adopters.
5. Regulation to mandate a limited range of specific standards.
6. Mandatory disclosure of derogation for non-standard projects and system changes.
7. Government support for industry in meeting the cost of change to comply with new standards.
8. Project investors (governments) refusing to finance projects not using specific harmonisation standards.
9. Develop a formal automatic mutual recognition scheme for rolling stock and adopt a national Type Approval framework with associated formal agreements.
10. Undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation.
11. Mandate that national training units of competency, skills sets and qualifications be delivered in the context of a generic railway, which is supported by a Guidance document.
12. Government investment in type approval technologies that help solve standards-related interface constraints.

1.2.2 Harmonisation Option Pathways

Standards harmonisation will be a long and continual journey, not a singular event. As such, option pathways (not just 'options') have been developed. These option pathways are packages of initiatives over time.

Reflecting the dichotomy between voluntary and mandatory standards regimes and approaches, ***Option 1: Voluntary Pathway*** has been developed as an 'enhanced status quo', with minimal regulatory change. Under this option pathway,

3 Path Dependency" refers to processes where past events and decisions constrain later events or decisions, as development along a certain path becomes increasingly entrenched.

harmonised standards would be co-designed by industry in high-benefit standard areas and using international precedents, with supporting incentive mechanisms. This co-design would be supported by strengthened governance architecture and industry collaboration mechanisms. This option pathway aims to foster a cooperative environment where the voluntary adoption of standards is rewarded, guided by strong governance and supported by incentives to stimulate industry participation. In terms of timing, this option pathway would take less than 10 years to implement in full, with the timeline for the realisation of full benefits depending on option efficacy.

Additionally, reflecting the public policy dichotomy between 'gradualist' and 'interventionist' approaches, ***Option 2: Gradualist Mandatory Pathway*** has been developed. Under this option pathway, there would be mandatory rail standard harmonisation across high-benefit standards areas and complete with technical specifications. This option pathway will prioritise grandfathering of effective solutions, only apply to new equipment and systems, will be multi-year, and have a range of approved derogation areas. The option pathway aims to enforce a selective mandate that targets areas with the greatest potential for benefit while providing a structured transition period and accommodating exceptions where necessary. The option pathway has been heavily informed and influenced by the EU's experience of implementing mandatory standards harmonisation, through the EU TSIs. In terms of timing, this option pathway would take approximately five to 10 years to implement in full, with full benefits not being realised until 25 to 30+ years after implementation, given the long life of rail assets in tandem with the grandfathering approach.

Additionally, considering the interventionist approach, ***Option 3: Interventionist Mandatory Pathway*** has been developed for assessment. Under this option pathway, there would be a phased transition of a stringent mandate for rail standards harmonisation across both new and some existing rail equipment, with minimal grandfathering arrangements for high benefit standard areas. To assist with the rapid transition resulting from the mandates, high levels of government funding (subsidisation) would be available to those that bear costs and make the pathway more viable. In terms of timing, this option pathway would take approximately five years to implement in full, with full benefits not being realised until 20 years after implementation, due to the need for a reasonable implementation timeframe, even without grandfathering.

These three option pathways are defined by the package of the initiatives that constitute them, in line with their overarching parameters. This packaging is outlined in Table 10 on page 65. Of note, similar initiatives are apparent in option pathway 2 as option pathway 3, given both involve mandating. The difference is in the speed (timeline) and the extent to which harmonisation is mandated and implemented.

1.2.3 Option Pathway Assessment

A Multi-criteria Analysis (MCA) approach was selected to assist with the complex decision-making process involved in selecting a 'preferred' option pathway, against the criteria of:

- Cost
- Certainty
- Stakeholders buy-in
- Timeliness
- De-risking
- Efficiency

A summary of the results of the MCA, where option pathways were assessed from 0 to 10 against each criterion weighted according to a Pairwise assessment undertaken by representatives from ARA, NTC, ONRIC, and RISSB, is provided in Table 1, below.

Table 1 Option MCA scoring summary

Option Pathway	MCA Score	Preference Ranking
1 – Voluntary	4.59	3
2 – Gradualist Mandatory	**6.89**	**1**
3 – Interventionist Mandatory	5.74	2

Based on the outcome of this MCA, Option Pathway 2 is considered the preferred option pathway.

1.2.4 Key Implementation Considerations

The benefits sought from harmonised standards do not materialise, either under the preferred option pathway 2 or under another option pathway, until the relevant and appropriate standards have been consistently adopted. As such, implementation considerations form an important part of achieving rail standards harmonisation. In this light, there are several key implementation considerations. They are as follows:

- **Capability and role of RISSB:** If the policy environment around rail standards harmonisation were to change (such as through mandating), then the capability and role of RISSB, which is currently configured for its role in a voluntary standards regime, would need to be reviewed and likely recast; to ensure the development of a sufficient quantity of quality standards.
- **Aligning Australia with international standards:** The benefits of rail standards harmonisation can be increased in certain, appropriate, areas if Australian standards are aligned to international standards, such as UIC, ISO, EN, and BS standards. To this end, several avenues could be considered in conjunction with an option pathway, such as mandatory international standards evaluation by RISSB.
- **Ensuring the best approach for developing standards with high adoption:** To ensure that the benefits of harmonisation are realised, national standards must be of high quality and have stakeholder buy-in. There are several ways of working to ensure this, such as increased resourcing and capability of RISSB, the direct adoption of proven standards from other jurisdictions (including overseas), and the mandatory involvement of RIM and RSO SMEs.
- **Enforcing mandatory harmonisation**: In implementing regulation to mandate a limited range of specific standards, there must be consideration for how mandating works in practice. The central avenue for mandatory standards enforcement in Australia is to include mandating and harmonisation-related standard compliance into the existing role of ONRSR, through an amendment to the RSNL.
- **Alleviating transition cost concerns:** Any process of rail standards harmonisation that enforces changes for RIMs and RSOs without compensation, will cause a loss in stakeholder buy-in. As such, consideration must be given to this area. This can take several forms, including only applying mandatory standards to new systems, and/or establishing a fund to compensate for costs incurred.
- **Independent regulation and centralised governance:** In the EU's rail standards harmonisation process, there is a pattern of increasing centralisation with a strong member-driven organisation, supported by a clear governance framework. There are also independent regulators in each jurisdiction, as well as a cooperative member-driven approach to the development of standards to drive interoperability. These examples present clear, positive, lessons learned for Australia.
- **Maintaining stakeholder buy-in:** Aside from simply alleviating cost concerns, the broader support of RIMs and RSOs is crucial in the development and adoption of rail standards. In this context, mandatory standards pose an inherent risk, as it would impede on RIMs and RSOs from being 'masters of their own destiny' under co-regulation. However, RIMs and RSOs also acknowledge that, especially in recent years, rail standards harmonisation has an industry-wide benefit.
- **Defining a continued role for co-regulation:** In any process of mandating national rail standards, consideration must be given to defining a continued role for co-regulation. Here, the avenue to pursue is to ensure that co-regulation remains the governing regulatory structure of Australian rail networks for all standards that are not considered 'high benefit' or a National Priority enough to be mandated.
- **Dealing with short-term non-compliance:** In an interventionist transition to mandatory standards, rapid changes could render the operations of RIMs and RSOs non-compliant unless impractical, costly changes are made. Time for transition is also required to minimise network disruptions. As a result, in any harmonisation process, it's still essential to create a framework that allows RIMs and RSOs to phase out existing methods that don't align with new standards, potentially over an extended period.
- **Managing continued infrastructure differences:** Differences across networks in physical rail infrastructure provide significant barriers to harmonisation. This means that standards are necessary, but not sufficient, for interoperability and broader benefit realisation. Other challenges, including disparate and incompatible infrastructure, will remain and will need to be addressed under any harmonisation option pathway.
- **Dealing with self-contained networks:** In any process to harmonise Australian rail standards, it is crucial to consider the unique operational requirements of self-contained rail networks. This is because self-contained rail networks operate independently, so would find no benefit in conforming to interoperability standards, though component manufacturing standards are still equally relevant.
- **Unintended consequences:** In any policy implementation process, it is important to consider the potential for unintended consequences. Unintended consequences in the context of rail standards harmonisation could range from minor disruptions in service to significant safety hazards, financial losses, or even systemic network failures.

1.2.5 Economic Analysis of Standards Harmonisation

Agnostic to the specific option pathways and related implementation considerations outlined above as well as throughout this report, the indicative benefits and costs of harmonising a select set of appropriate standards have been quantified. This analysis focussed on areas of high benefit standards, especially for interoperability and manufacturing, with consideration for the transition to net zero.

The summary of the economic analysis in terms of the net present value (NPV) and the breakdown of the quantified economic benefits associated with standards harmonisation, is provided in Figure 1, with sensitivities.

Figure 1 Net present value of harmonisation programme ($M)

Summary	Base Scenario	High Scenario	Low Scenario
Net present value	**$1,721**	**$2,170**	**$829**
Benefits in $m	**$1,825**	**$2,282**	**$913**
Direct cost savings	$1335	$1,668	$667
Less road damage	$402	$502	$201
Better safety - road	$48	$60	$24
Fewer GHGs	$38	$48	$19
Better safety - rail	$3	$4	$2
Costs in $m	**$104**	**$112**	**$84**

In the **Base Scenario**, the net benefits of the full harmonisation programme are $1.7 billion in net present value terms, consisting of $1.8 billion in benefits and $104 million in costs (assuming grandfathering).

Also worth noting is that around 22% of the benefits accrue to state and federal governments outside of the rail sector (less road damage, $402 million net present value terms) and to road users through fewer deaths and injuries involving trucks (over $48 million by a very conservative estimate).

The **High Scenario** results in net benefits of the full harmonisation programme of $2.2 billion in net present value terms, consisting of $2.3 billion in benefits and $112 million in costs.

The **Low Scenario** results in net benefits of the full harmonisation programme of $0.8 billion in net present value terms, consisting of $0.9 billion in benefits and $84 million in costs.

A full breakdown of the approach, assumptions, and methodology is presented in Section 7 of this Report.

1.3 Harmonisation Priorities and Key Findings

Based on the analysis contained within this Report, the key finding is as follows:

A relevant national entity should lead the development of a National Rail Standards Harmonisation Strategy and accompanying Roadmap, based on the Preferred Option Pathway (Option 2: Gradualist Mandatory Pathway). This Strategy and Roadmap should consider the identified key implementation considerations, as well as Option Pathway-specific initiative implementation considerations. This Strategy and Roadmap should also be developed in collaboration with RIMs and key RSOs, to establish a shared vision across the sector for the future of rail standards harmonisation.

Additionally, this Report makes several further key findings to help enable and facilitate the central finding. Note that the specifics of these key findings are subject to further evaluation and consideration as part of a governance review to assess supporting arrangements, functions, and responsibilities, which would be required to support rail standards harmonisation under the preferred option pathway 2. These enabling and facilitating key findings are detailed in Section 8 of this Report.

2. Introduction

2.1 Australia's Rail Network

2.1.1 Australian Rail Network Development History

Australia's first railway networks were all developed independently of each other several decades prior to Federation, when the nation's current States were separate self-governing colonies. As such, and given the distances between these first networks, little consideration was given to how they might operate together as an 'Australia-wide' network. Instead, these railways were disjointed from each other and focussed more on linking regional areas to population centres and ports, rather than from city to city[4].

Since Australia's rail networks developed independently of each other, when the networks were first expanded to connect different States, the gauges, equipment, operating practices, and other key technical considerations were incompatible. This led to physical 'breaks-of-gauge', where passengers and freight had to be offloaded from one rail network and onloaded onto another at rail junctions and State boarders. These breaks-of-gauges persisted long after Federation, with 14 break-of-gauge locations in existence at the outbreak of World War II in 1939[5].

In the latter half of the 20th century, successive Australian Governments sought to connect mainland State capital capitals on a single standard gauge network. However, it wasn't until 1995, with the conversion of the Adelaide to Melbourne corridor to standard gauge, that all mainland State capitals were linked by a network of the same gauge[6]. In 1998, the Australian Rail Track Corporation (ARTC) was also incorporated as an Australian Government-owned statutory corporation to manage sections of the interstate rail network. This was the first time in the development of the rail network on the Australian continent that the network could be considered truly 'national'.

Despite the existence of a national, standard gauge, rail network, limited subsequent progress has been made towards more wide-reaching cross-network harmonisation, with many rail entities continuing to have standards, codes, and rule books, which were developed during their time as separate State-based entities[7].

Ultimately, Australia is living the enduring legacy of disjointed networks that were established pre-Federation, with this legacy continuing the create challenges today.

2.1.2 Rail in Australia Today

Nature of the Australian Rail Network

Largely because of its origin in separate State-based networks, Australia's rail network is not a singular system, but instead the composition of 29 different and distinct networks. It is large and complex, involving an estimated 197 accredited operators on approximately 51,100 kilometres of track[8].

Also owing to the fragmented development pathways of the different networks that comprise the Australian rail landscape, the nation has a variety of key technical and operational disparities. Perhaps the most well-known of these disparities is Australia's 3 different rail gauges across the nation (see Figure 2). However, rail gauges aside, numerous other disparities exist, including the presence of 11 separate signalling and train control systems and 17 safe-working systems[9]. Other specific differences include, but are not limited to, the following:

- Different axle load limits.
- Different structure of gauges.
- Different loading outlines.
- Different permitted rolling stock outlines.

4 Australian Rail Track Corporation (ARTC). "The Rise, Decline, and Rise of Australia's Railways." Australian Government and ARTC, N.d.

5 Laird, Philip G. Back on track: rethinking transport policy in Australia and New Zealand. UNSW Press, 2001. Pg., 187.

6 Australian Rail Track Corporation (ARTC). "The Rise, Decline, and Rise of Australia's Railways." Australian Government and ARTC, N.d.

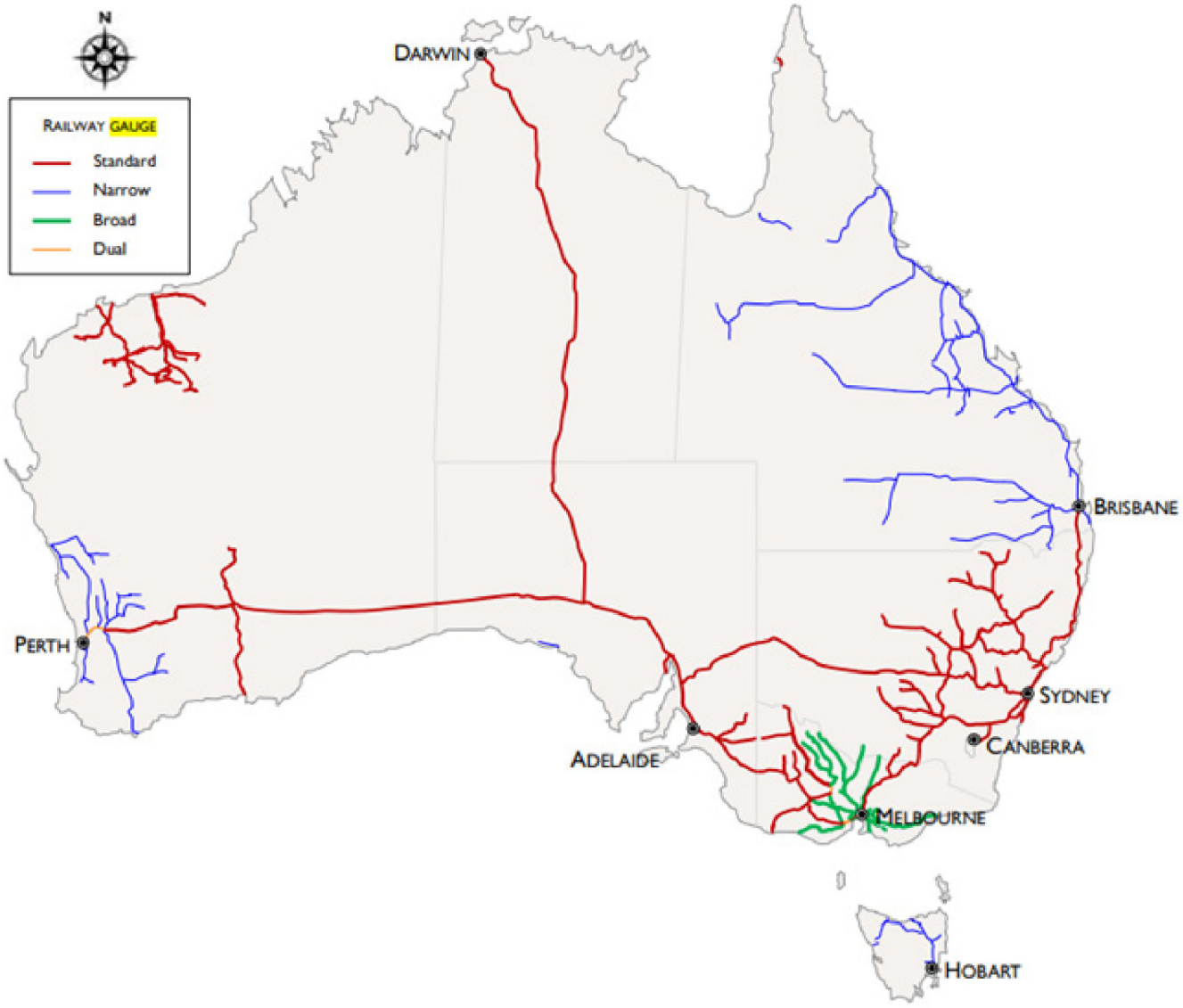
7 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 4.

8 Office of the National Rail Safety Regulator (ONRSR), Rail Safety Report 2022–2023. ONRSR, 2024. Pg., 9. Number of accredited operators is correct as of 18 September 2023.

9 SYSTRA. Interoperability: The fast track to a seamless, safer railway system. SYSTRA ANZ, 2023. Pg., 5

- Different kinematic envelopes[10].
- Different platform heights.
- Different platform clearances.
- Different ruling grades.
- Different permissible grades.
- Different locomotive performance characteristics.
- Different rolling stock for similar functions.
- Different overhead power current types and voltages[11].

Figure 2 Australia's network of railways by gauge, October 2022[12]



This fragmentation of the network can be problematic for existing or prospective rail freight and passenger operators to navigate given that, aside from suburban services, a significant proportion of trips in Australia involve operation across two of more networks, which often have varying standards, codes, and rule books, as well other key technical and operational characteristics[13].

10 NOTE: Kinematic envelope refers to the outline of the space occupied by a rail vehicle when it is in motion. Essentially, it represents the largest volume that rolling stock can occupy as it travels along a railway track at speed

11 Rail Industry Safety and Standards Board (RISSB). Rail Systems Interoperability Guidelines. 2015. Pg., 14.

12 Bureau of Infrastructure and Transport Research Economics (BITRE). Trainline 10. DITRDCA, 2023. Figure 45 on Pg., 77.

13 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Explanatory Paper. Palazzi Rail (for RISSB), 2022. Pg., 6.

Operational realities aside, the rolling stock and related component procurement processes also vary significantly between networks. Not only do different networks require different rolling stock specifications to meet the standards of different networks, but State governments and/or RSOs also procure rolling stock at different periods, aligning with their unique budget cycles. Additionally, each jurisdiction typically has different commitments to the use of local content in rolling stock and rolling stock components, as well as often define 'local' differently"[14]. This works to create a highly fragmented national market for rolling stock and rail equipment products.

Economic Impact of the Australian Rail Industry

Despite the fragmented nature of the Australian rail network, the various network infrastructure managers, operators, and suppliers that constitute the Australian rail industry are significantly important to the Australian economy.

In 2019, it was estimated that the rail industry contributed approximately AU$30 billion to the national economy, and directly and indirectly employed more than 165,000 FTE workers. This overall contribution consisted of AU$16.1 billion of payments to employees and AU$13.7 billion in the gross operating surplus (GOS). This overall contribution represents around 1.5% of Australia's 2019 Gross Domestic Product (GDP)[15].

In the same 2019 report, the rail rolling tock manufacturing and repair industry specifically was estimated to have a revenue of just over $2.4 billion, with a direct value-added of $515 million, directly and indirectly supporting 4,087 FTE workers[16]. The rail rolling stock manufacturing and repair industry are also crucial to the local economies of the predominantly regional towns in which key facilities and supplier hubs are located, as illustrated in Figure 3.

Figure 3 Top 10 regional rolling stock manufacturing and repair employment clusters in Australia[17]

14 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 12.

15 Deloitte Access Economics (DAE). Value of Rail 2020: The rail industry's contribution to a strong economy and vibrant communities. DAE (for ARA), 2020. Pg., 3.

16 Deloitte Access Economics (DAE). Value of Rail 2020: The rail industry's contribution to a strong economy and vibrant communities. DAE (for ARA), 2020. Pg., 17.

17 Deloitte Access Economics (DAE). Value of Rail 2020: The rail industry's contribution to a strong economy and vibrant communities. DAE (for ARA), 2020. Pg., 18 (Figure 2.9: Top 10 regional rolling stock manufacturing and repair employment clusters in Australia).

2.1.3 Key Rail Stakeholders

The Australian rail industry is composed of a variety of key stakeholders. These stakeholders primarily consist of Rail Infrastructure Managers (RIMs), Rolling Stock Operators (RSOs, or 'Operators'), and rail equipment suppliers. There are also several 'other' stakeholder groups, including unions, rail consultants, rail-connected port operators, and academic institutions.

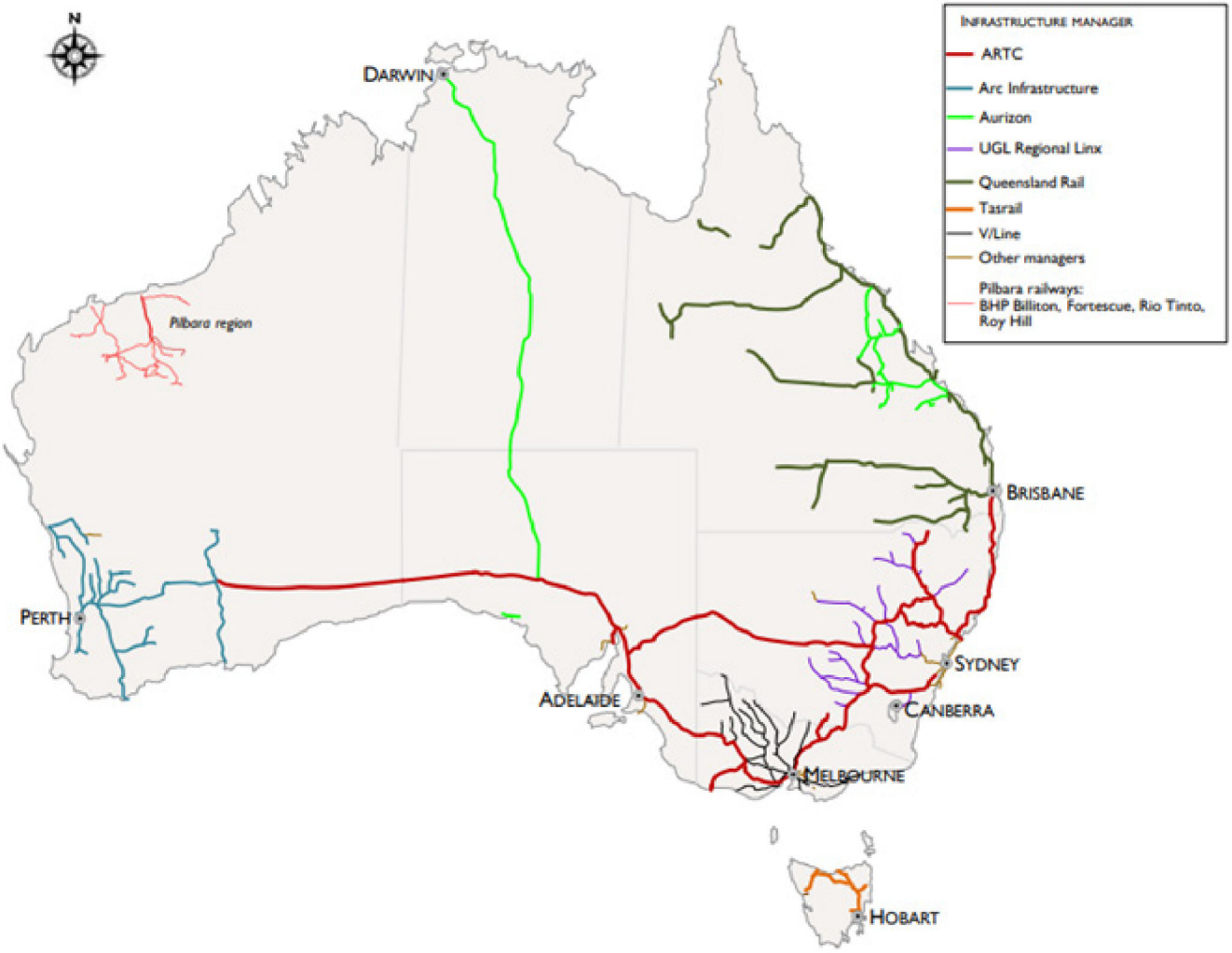
These stakeholders are each discussed in the subsections below.

Rail Infrastructure Managers (RIMs)

Under the Rail Safety National Law (RSNL), which is the prevailing legislative framework for the Australian rail industry (see 2.2.2), RIMs are the entity responsible for managing the network in a safe manner. The RIM is defined as "the person who has effective control and management of the rail infrastructure" and, as such, is charged with accountabilities under RSNL for day-to-day safety of operations on a network.

RIMs are typically, though not exclusively, State-Government based organisation, because of the State-based origins of Australia's rail networks (See Section 2.1.1). There are several different RIMs in Australia, as outlined in Figure 4.

Figure 4 Australian railways, by RIM (as of December 2022)[18]



Rolling Stock Operator (RSO)

An RSO or Operator, in accordance with the RSNL, is defined as "the person who has effective control and management of the operation or movement of rolling stock on rail infrastructure". Further, the RSNL clarifies that the RSO should not be taken to be the individual train driver or signaller, but rather the entity accountable for the operation.

18 Bureau of Infrastructure and Transport Research Economics (BITRE). Trainline 10. DITRDCA, 2023. Figure 59 on Pg., 112.

RSOs must respond to decisions made by each RIM on the routes upon which they operate. In addition, these above rail transport operators also develop some standards of their own for the networks on which they operate.

Across Australia, various RSOs are also the RIMs for some part or for all the track that they operate on. This is known as a 'vertically integrated' structure as opposed to a 'separated' structure, whereby the RIM and RSO are separate entities.

Of the over 50 RSOs in Australia, they typically fall into one of the following categories, as outlined in Table 2.

Table 2 RSO overview in Australia[19]

RSO type	Examples
Heavy rail urban passenger	Typically, vertically integrated, and publicly owned entities, including: – Queensland Rail. – Sydney Trains (TfNSW). – Transperth (PTA-WA). Also include Metro Trains Melbourne (MTM), which is a privately-owned joint venture, as well as Keolis Downer, which operates trains on the Adelaide network on behalf of the South Australian Government.
Non-urban passenger services	Typically, vertically integrated, and publicly owned entities, including: – Queensland Rail. – NSW TrainLink (TfNSW). – V/Line. – Transperth (PTA-WA).
National rail freight operators	Typically, privately-owned entities, including: – Pacific National. – SCT Logistics. – QUBE Logistics. – Aurizon. – Southern Shorthaul Railroad. Some freight operators (including Aurizon and Pacific National) also operate natural resource-focussed operations, especially for coal in Central Queensland and in the Hunter Valley.
Regional rail freight operators	As for national rail freight operators, plus select others, including: – TasRail (in Tasmania). – Watco (in WA and Queensland).
Mining Operators	Several mining companies operate rail networks associated with iron ore extraction in the Pilbara. These entities are: – Rio Tinto. – BHP. – Fortescue Metals Group (FMG). – Roy Hill.

Rail Equipment Suppliers

A 'rail equipment supplier' refers to a company or organisation that provides various products and services necessary for the operation and maintenance of railroads, across the rail value and supply chains. These can include, but are not limited to:

19 Adapted and present by GHD, from: Bureau of Infrastructure and Transport Research Economics (BITRE). Trainline 10. DITRDCA, 2023. Pg., 114.

- Rolling stock, including engines, carriages, wagons, and other vehicles that move on a railway.
- Rail infrastructure, including tracks, signals, switches, and other equipment used to control and guide trains.
- Maintenance equipment, including machinery and tools used for repairing and maintaining rails, trains, and related infrastructure.
- Safety equipment, including signalling systems, crossing gates, and other devices designed to ensure the safe operation of trains.
- Technology and software, including train control systems, scheduling software, and other digital solutions used in modern rail operations.

In Australia, there are several domestic and international rail equipment suppliers. These include, but not limited to, the following:

- Alstom.
- Downer Group.
- Hitachi Rail.
- Knorr-Bremse.
- Siemens.
- UGL Limited.
- Unipart.
- Wabtec.

2.2 Rail Standards in Australia

2.2.1 What are Standards?

RIMs, RSOs, and rail equipment suppliers are all governed by the various standards that exist within the Australia rail industry. 'Standards', as defined by Standards Australia, are defined as the "documents that set out specifications, procedures and guidelines that aim to ensure products, services, and systems are safe, consistent, and reliable"[20].

Standards serve several purposes in the Australia rail industry, including to ensure safety and to improve efficiency, by providing rail procurers with more products and operating practices, and rail equipment suppliers with larger more consistent market that they can sell to[21].

Broadly speaking, standards can also be broken down into 'Components Standards', which allow for interchangeability of equivalent parts from multiple suppliers, and 'Systems Standards', which provide a framework for how multiple subsystems work together to achieve a goal[22].

Importantly, standards can be differentiated from other, similar documents, including Codes of Practice", "Guidelines", as well as "Rules and Procedures". The general difference between them in an Australian rail sector context is as follows, with consideration for how they manifest and relate to one another:

- **Codes of Practice ('Codes'):** Generally, practical guides that outline what RIMs and RSOs need to do. They serve as a benchmark for the minimum standard of practice and are used to guide rail sector professionals in their work. Standards typically provide the "how to" of executing the Codes.
- **Guidelines:** Advice on actions to undertake in a situation, with a recommended but non-mandatory control. They are designed to streamline processes according to best practices and are open to interpretation. While standards are mandatory requirements that dictate specific behaviours or processes, guidelines are non-binding recommendations that typically include advice on how to meet those standards.
- **Rules and Procedures[23]:** Outline the requirements of a specific product or activity, as a so-called 'cookbook' for rail sector workers to consult to accomplish a repeatable process. While standards establish the essential requirements and expected outcomes, rules and procedures provide the detailed steps to achieve compliance with those standards.

20 Standards Australia. What is a Standard? N.d., https://www.standards.org.au/standards-development/what-is-standard.

21 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 11.

22 Wabtec Corporation. Standards and Interoperability. Presentation Slides, 17 November 2023.

23 NOTE: Also called "specifications", depending on the context.

2.2.2 Australia's Rail Standards Regime

The central legislation in the Australia's rail standards regime is the *Rail Safety National Law* (RSNL). Under the RSNL, RIMs and RSOs participate in a process known as 'co-regulation'. Each of these concepts is discussed in the subsection below.

Rail Safety National Law (RSNL)

In July 2009, as part of the then Government's 'Seamless National Economy' agenda, the Council of Australian Governments (COAG) agreed to national transport regulation reforms including the establishment of a *Rail Safety National Law* (RSNL), and the Office of the National Rail Safety Regulator (ONRSR), across Australia. The reform aimed to resolve the preceding centuries' inconsistent regulatory practices, which originated from the existing, vertically integrated, state-based monopoly arrangements.

The RSNL was developed with the principles of shared responsibility and accountability, taking a so-called 'outcomes-based' approach. Importantly for rail standards development in Australia, this 'outcomes-based' approach does not explicitly prescribe the specific standards and rules needed to ensure the safe operation of the rail network, which influences Australia's standards regime and standards development process accordingly.

Co-regulation

The process for developing and applying rail standards under the current structures and legislation, including the RSNL, is known as 'co-regulation'. Under co-regulation and the RSNL, Australian governments do not directly prescribe, mandate, or otherwise enforce the specific standards under which RIMs and RSOs need to operate. Instead, the governments set a performance requirement on railways to operate safely, allowing the RIMs and RSOs to develop, review, and implement whatever standards they deem necessary to meet these requirements[24]. The relevant regulator (ONRSR) only confirms that the standards that the RIMs and RSOs enact are compliant with the performance requirements in a nationally consistent way[25].

The co-regulatory structure under the RSNL assumes the pre-eminence of each individual network and relevant RIM and RSO in making decisions and in establishing and implementing standards related to that individual network. The absence of a 'one rule for all' approach enables RIMs and RSOs to tailor standards to their specific operations and corollary risk profiles, also enabling ONRSR to tailor the regulatory approach to individual circumstance, or to specific safety challenges[26].

However, the consistent approach to performance requirements in the RSNL and Australia's co-regulatory structure does not mean that RIMs and RSOs make a consistent decision regarding what standards need to be implemented to meet those requirements. Nor does it guarantee that one RIM or RSO's standards will be aligned with another's in any functional way[27]. Instead, it is wholly left for individual RIMs and RSOs to consider if there is a business case for any change in their operation, including in their standards, fully on their own accord[28].

As a result of the performance-based, co-regulatory regime in across Australia, the nation's 13 distinct networks are frequently subject to bespoke standards that govern only the systems, processes, and technologies on that network, and which are often incompatible with systems, processes, and technologies of other networks[29]. This can pose an operational complexity for Australia's rail network, given that a decision made by one RIM can have implications for the following:

- Adjacent RIMs, as varying standards can cause issues around how a given train transitions across a boundary.
- RSOs operating under adjacent RIMs, as they may be required to fit varying compatible equipment to rolling stock to respond to the varying standards on the different networks[30].

24 Office of the National Rail Safety Regulator (ONRSR). The ONRSR Way: Regulating Rail Safety. ONRSR, 2021. Pg., 11.

25 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 4.

26 Office of the National Rail Safety Regulator (ONRSR). The ONRSR Way: Regulating Rail Safety. ONRSR, 2021. Pg., 12.

27 Office of the National Rail Safety Regulator (ONRSR). The ONRSR Way: Regulating Rail Safety. ONRSR, 2021. Pg., 13.

28 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 3.

29 Productivity Commission (PC). National Transport Regulatory Reform (Draft Report). PC, 2019. Pg., 9.

30 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Explanatory paper. Palazzi Rail (for RISSB), 2022. Pg., 11

2.2.3 Rail Industry Safety and Standards Board (RISSB)

Role of RISSB

Within the Australian rail standards ecosystem, the Rail Industry Safety and Standards Board (RISSB) is the only accredited developer of rail industry safety standards in Australia. It develops standards, codes of practice, guidelines, and rules that enable the rail industry to meet the safety requirements set out in the RSNL in a consistent way across networks and makes them available to its members.

RISSB was established in 2003 as the Code Management Company as part of the Australasian Railway Association (ARA), before spinning off from the ARA to become an independent organisation with a revised constitution and Board in 2014. RISSB is a not-for-profit organisation that relies on voluntary financial contributions through annual membership, as well as State and Commonwealth Government funding, currently through a 2-year memorandum of understanding (MoU) while the NTC, at the direction of Ministers, progress consideration of national standards governance arrangements. Significant 'in kind' resources are also provided to RISSB by its members, including RIMs, who often supply staff and other non-financial resources and expertise to help develop and review the standards that RISSB produces[31].

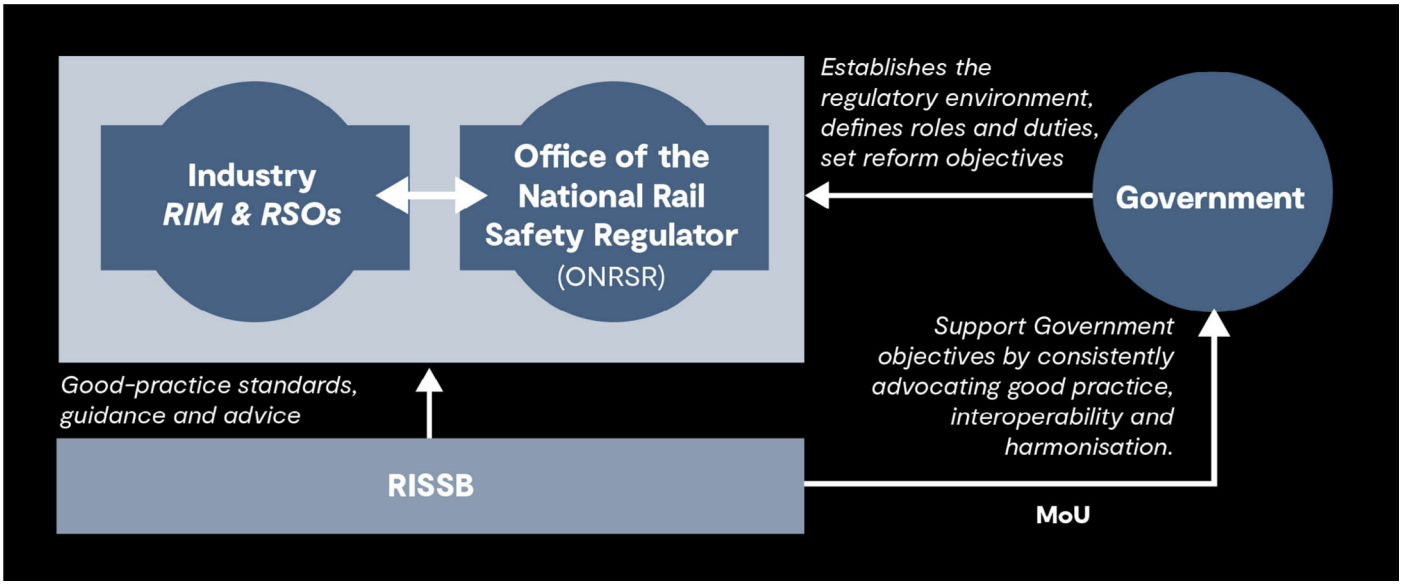
Recognising that there are major inefficiencies that result from the proliferation and use of differing standards across the Australian rail industry, RISSB's objectives are defined in its Company Constitution to chiefly include being to:

> *"Develop, manage and promote a suite of standards, rules, guidance materials and other documents ... to assist the rail industry to manage rail safety, improve efficiency and achieve safety outcomes through standardisation, interoperability[32] and harmonisation".*

Importantly, the standards and products that RISSB produces rely on being voluntarily adopted by RIMs and RSOs. It does not have, nor is it intended to have, the authority to mandate its products in any way, allowing individual RIMs and RSOs to consider the relative merit of adopting a RISSB product, relative to developing their own standard that is unique to their operating circumstances.

The role of RISSB in the Australian rail ecosystem, alongside RIMs, RSOs, ONRSR, and Government, is illustrated in Figure 5.

Figure 5 Role of RISSB in the Australian rail ecosystem



Level of Adoption of RISSB Products

The level of adoption of RISSB products among RIMs and RSOs, relative to RIMs and RSOs choosing to develop their own standards, varies significantly. This is unsurprising given Australia's non-prescriptive, co-regulatory environment.

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31 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 2.

32 Interoperability is defined in Section 3 of RISSB's AS 7450:2013 standard as meaning "the ability of a process, system or a product to work with other processes, systems or products".

In a 2016 RISSB customer satisfaction survey, across all 60 of RISSB's standards products, the average level of full implementation is 11%, while the average level of full or part implementation was 31%, and the level of non-implementation was 31%[33]. There was non-implementation across a range of product categories[34].

At an earlier 2014 survey of RISSB products found that while the adoption rate was as high as 52.7% in the 'locomotives' product group, the average level of adoption of RISSB Australian Network Rules and Procedures (ANRP) and Interoperability products was 26%[35]. Additionally, although the 2014 survey predicted that future adoption rates as high as 89.5% (in the locomotives product group) could be achieved, such high rates have not eventuated. More commonly, standards related to areas including rolling stock, track structures and level crossings are more likely to be RISSB products, while standards related to signalling, train control, operational technology and protocol, telecommunications, overhead line equipment, and traction power equipment, are more commonly developed by RIMs themselves[36].

Importantly, the positive effect of RISSB's standardised products is highly dependent on their level of adoption. This is because the absence of widespread adoption leads to the operational inconsistencies across different networks persisting, which undermines the purpose of developing nationally consistent standards. This risks RISSB's products contributing toward a so-called "Esperanto Effect"[37], whereby a universal standard is developed to gain the benefit of scale from universal adoption, but ends up becoming one standard among many, adding to the fragmentation it sought to alleviate.

2.2.4 Quantum of Standards

RISSB has 123 current standards available, with 62 superseded[38]. While this number is substantial, it is still 20 standards less than the 143 mandatory interoperability-specific standards functioning in the European Union (EU) as of 2021 (see Section 2.3.1)[39].

A significant body of standards are also developed and held by individual RIMs and RSOs. However, the specific quantum is hard to accurately determine, due to the lack of information sharing by RIMs and RSOs, both publicly and within themselves (see Section 4.2.2), including for commercial-in-confidence reasons.

That said, some publicly available estimates and related parameters for key RIMs includes the following:

– TfNSW: 481 current standards across heavy rail (HR), light rail (LR), and metro (MT)[40].

2.3 Global Rail Standards Regimes

2.3.1 European Union (EU)

Pre-Reform Era

Prior to the 1990s, when European Union (EU)-wide railway reforms began, the EU's rail network in many ways resembled the current state of the Australian rail network. Indeed, although Australia's rail network is fragmented by the predominantly State-based RIMs that compose it, and the EUs was fragmented by a nation-based organisational structure, similar, significant, technical and operational differences existed. These divergencies included the following:

– Five types of electrification system.
– 19 signalling systems.
– Five track gauges.
– Five classes of axles load.

33 Insync. RISSB Customer Satisfaction Survey Report. Insync (for RISSB), 2016. Pg., 1.

34 Insync. RISSB Customer Satisfaction Survey Report. Insync (for RISSB), 2016.

35 Strategex. A Survey of Rail Industry Safety Standards Board Products. Strategex (for RISSB), 2014. Pg., x.

36 See: Stakeholder Engagement Report (Appendix A).

37 NOTE: Esperanto is a constructed auxiliary language that was developed 1887 by Polish ophthalmologist L. L. Zamenhof to make international communication easier. However, the language only ever received a low level of international adoption, meaning that it contributed to the fragmentation that it sought to eradicate.

38 Standards Australia. Standards Catalogue, RISSB: Railway Industry Safety and Standards Board. 2024. https://www.standards.org.au/standards-catalogue/others/standards-by-sdo?sdo=RISSB.

39 UNIFE. The Technical Framework of the European Railway Sector. UNIFE, 2021. Pg., 3.

40 Transport for New South Wales (TfNSW). Find a Standard. TfNSW, 2024. https://standards.transport.nsw.gov.au/search-standard/

– Six clearance gauges.
– Various nationally specific operational rules.[41]

Importantly, the EU's persistent differences in gauge width, electrical voltages, signalling systems, platform dimensions, loading parameters, operational rules, and training, all led to a distinct lack of bloc-wide interoperability. This caused operational complexities and increased cost for operations, which were passed onto freight and rail customers, as well as impeded the secondary markets for rolling stock and other rail equipment[42].

Railway Packages, Directive (EU) 2016/797, and TSIs

Within the EU, increased rail interoperability through harmonised standards has been an objective of policymakers for several decades[43]. However, it wasn't until the 1990s that several railway "packages" were crafted with the high-level intention of constructing a more efficient, competitive, and sustainable 'Single European Railway Area' (SERA)[44], whereby any European railway undertaking may operate services on any rail network and in any country of the European Union[45].

The railway packages have formed part of various reform activities to integrate and liberalise the rail market more generally. Indeed, reforms to harmonise standards in the EU have been introduced alongside other measures such as the evolution of the Trans-European Transport Network (TEN-T), which focusses on integrating rail freight corridors across the EU, and interoperability across those networks. The overall reform agenda in the EU can be broken down into four broad phases.

First Railway Package (2001)

The EU's first railway package laid the future groundwork for reform including the process of standards harmonisation. It included the following:

– The potential to introduce greater competition in the market by introducing alternative models to vertical integration. However, this has not been taken up in most major jurisdictions, other than the UK.
– Setting up the initial steps for building consistent rail access schemes across jurisdictions, in preparation for the opening of international services (for example, between SNCF and Deutsch Bahn international services, including Eurostar services into the UK).
– The separation of rail policy and operations, with the establishment of independent regulators in each EU member state and the concept of rail undertakings, subject to regulation in each jurisdiction.

The first package laid the foundation and architecture for subsequent reforms, but resistance from member states and the lack of mechanisms to effectively coordinate across jurisdictions slowed progress.

Second Railway Package (2004)

The second railway package focused on the opening of inter-jurisdictional services and the process for increasing interoperability between states. The second package codified rail licensing for infrastructure managers and operators and the process to harmonise rail safety standards through the establishment of the European Rail Agency (ERA) as a central authority responsible for vehicle standards with a positive obligation to promote (but not enforce) interoperability. Although this was a step forward, challenges remained in terms of access and charging, particularly between the French and Germans.

Third Railway Package (2007)

The third railway package focused on the liberalisation of domestic markets to promote competition and on promoting consistent investment in infrastructure by EU member states, including requiring projects with EU funding to demonstrate how interoperability standards would be applied. It continued to emphasise the importance of cooperation including new measures to strengthen the independence of national regulatory bodies.

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41 European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 21.

42 Di Pietrantonio, Loris, and Jacques Pelkmans. The Economics of EU Railway Reform. Bruges European Economic Policy Briefings No. 8, 2004. Pg., 14-15.

43 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 16.

44 UNIFE. The Technical Framework of the European Railway Sector. UNIFE, 2021. Pg., 1.

45 Federal Ministry for Digital and Transport (Germany). European Railway Policy. https://bmdv.bund.de/SharedDocs/EN/Articles/G/EU-Policy/european-railway-policy.html.

Fourth Railway Package (2016)

The fourth railway package introduced broad reforms including a strengthening of the role of the ERA to ensure the effective implementation, enforcement, and monitoring of the standards to drive interoperability across member states. This included the streamlining and mutual recognition of type certification across the EU.

This EU fourth railway package reform process culminated in Directive (EU) 2016/797 of the European Parliament and of the Council of 11th of May 2016, on the interoperability of the rail system within the European Union. This Directive has been applicable since the 1st of November 2020.

Most significantly, Directive (EU) 2016/797 established revised 'Technical Specifications for Interoperability' (TSIs), which define the technical and operational standards that must be met by each structural or functional subsystem, or part of a subsystem, to meet essential requirements and ensure the interoperability of the EU's railway system[46]. The Directive establishes the "why" of what is being done, with the TSIs describing "what" needs to be done to support the directive, and the TSIs also quoting the specific standards that set out the "how"[47].

Currently, there are 11 TSIs in publication within the EU, working to enable the interoperability of products and technologies by defining specifications in the following areas:

- Control command and signalling.
- Energy.
- Infrastructure.
- Noise.
- Operation and traffic management.
- Persons with disabilities and with reduced mobility.
- Rolling stock - locomotives and passengers.
- Rolling stock - freight wagons.
- Safety in railway tunnels.
- Telematics applications for passenger service.
- Telematics applications for freight service[48].

In total, these TSIs today reference 143 individual standards, which are mandatory for any EU RIM or RSO equivalent to follow[49].

Furthermore, the TSIs only apply to new rail vehicles, as well as conditionally to renewed and upgraded subsystems on a conditional basis[50]. This ensures the progressive implementation of rail interoperability and the gradual replacement of diverging and inoperable legacy systems, as rolling stock and track infrastructure are replaced[51].

Additionally, the mandatory TSI framework under Directive (EU) 2016/797 is supplemented by voluntary notified national technical rules (NNTRs)[52]. These NNTRs apply to the aspects of the EU rail system not linked to interoperability, as well as in the following defined circumstances where a derogation is applicable:

- To ensure technical compatibility with the legacy rail system, where it is not designed and built to TSIs.
- Where special provisions or specific cases are needed in the TSIs, either temporary or permanent.
- Where a national rule provides a solution for the open point[53].

Ultimately, the role of mandatory and voluntary standards within the EU rail standards hierarchy outlined above, is illustrated in Figure 6.

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46 European Union Agency for Railways. Technical Specifications for Interoperability. https://www.era.europa.eu/domains/technical-specifications-interoperability_en.

47 International Union of Railways (UIC). Railway Standardisation Strategy: Europe. UIC, 2016. Pg., 10.

48 European Union Agency for Railways. Technical Specifications for Interoperability. https://www.era.europa.eu/domains/technical-specifications-interoperability_en.

49 UNIFE. The Technical Framework of the European Railway Sector. UNIFE, 2021. Pg., 3.

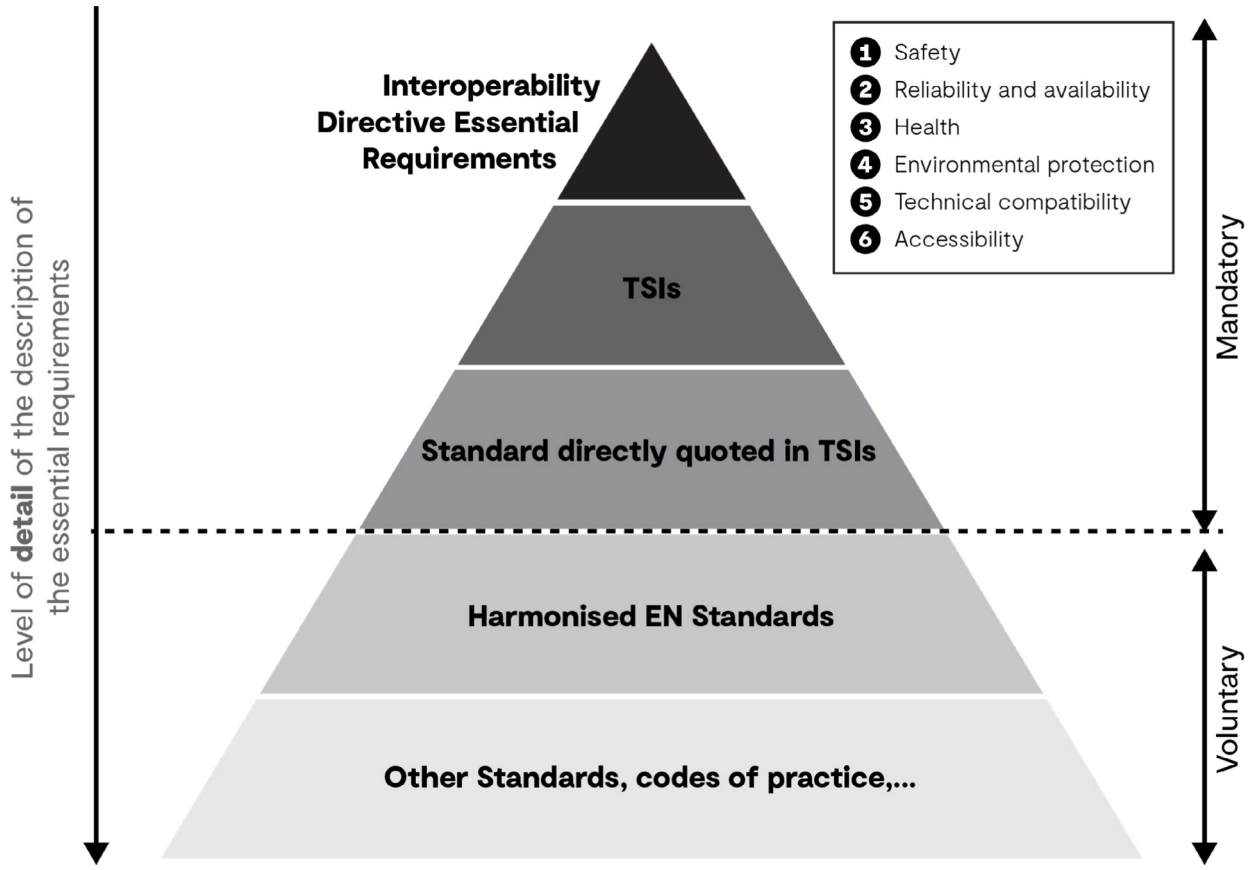
50 Cited in: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 20.

51 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 17.

52 European Union Agency for Railways. Standards and Interoperability: A European Perspektive. Presentation Slides, 17 November 2023.

53 UNIFE. The Technical Framework of the European Railway Sector. UNIFE, 2021. Pg., 6.

Figure 6 EU rail standards hierarchy[54]



Even in non-EU members such as the UK, compliance with the EU TSIs is compulsory via relevant legislation and/or international agreements, for lines that connect to the European railway system[55].

Continued Interoperability Challenges

While the implementation of Directive (EU) 2016/797 and related TSIs have undoubtedly increased the interoperability of the EU's rail network, progress has still been slow, and is uneven between nations and networks. This is, in part, because TSIs only apply to new and upgraded vehicles and systems, and that rail assets typically have a long-life nature[56].

As an example of persistently low TSI coverage, the degree of implementation by operators concerning telematics applications varies considerably among functions and is progressing very slowly. For passenger services, the application rate is only marginally above 50%, while for freight services, only two functions have been fully implemented by more than 65% of operators[57].

Additionally, within the EU, the non-application of TSI requirements remains common practice. This is visible from the high number of derogation requests from the mandated TSI, which not only remain significant across EU Member States, but also display substantial variation[58].

54 UNIFE. The Technical Framework of the European Railway Sector. UNIFE, 2021. Pg., 1.

55 Rail Safety Standards Board (RSSB). The scope and force of mainline railway standards and rail-specific legislation. N.d., https://www.rssb.co.uk/-/media/Project/RSSB/RssbWebsite/Images/Content-Images/scope-and-force-of-standards-large-image.jpg.

56 European Union Agency for Railways. Report on Railway Safety and Interoperability in the EU. European Union Agency for Railways, 2022. Pg., 64.

57 European Union Agency for Railways. Report on Railway Safety and Interoperability in the EU. European Union Agency for Railways, 2022. Pg., 64.

58 European Union Agency for Railways. Report on Railway Safety and Interoperability in the EU. European Union Agency for Railways, 2022. Pg., 65.

2.3.2 United States of America (USA)

Increasing Progress Towards Harmonisation

Although, like in Australia, the North American rail networks is characterised by significant geographical specialisation, unlike in Australia, the development of the American rail network has been a journey towards increasing uniformity, which has followed a series of U.S. Federal Government mandates. In 1886, Congress designated the standard gauge across the nation, 109 years before all Australian State capital cities were linked by standard gauge track. This was followed by similar harmonisation mandates in the late 19th century, including the implementation of uniform brake and coupler standards in 1893[59].

Additionally, American railroads were nationalised during World War I, which led to the nation-wide uniformity of rail equipment and related standards[60]. This did not occur in Australia, where rail transport was not even centrally coordinated, let alone controlled or standardised, until 1943, during the height of the Second World War's Pacific Theatre[61].

Rail Safety Improvement Act of 2008 (RSIA) and Current Prescriptive Regulations

The most significant recent development in standards harmonisation in the USA has been the *Rail Safety Improvement Act* of 2008 (RSIA). The RSIA mandated the implementation of Positive Train Control (PTC), which was completed in 2020. Interestingly, although the RSIA de-facto mandates PTC interoperability, the impetus for the legislation was not to improve interoperability directly (unlike EU Directive 2016/797), but to improve rail safety following the 2008 Chatsworth train collision[62].

The RSIA and mandate for PTC also extends to Canadian companies operating on American railroads[63], which helps ensure cross-border interoperability for freight and passenger rail. In February 2022, Transport Canada also published a Notice of Intent describing how it intended to implement PTC across Canada by 2030, which will improve broader North American rail interoperability. [64] [65]

Largely because of the RSIA, Class I railroads (i.e., railroads with annual revenue of at least $900 million[66]) in the USA are nearly fully interoperable, with 91.6% of the network reaching interoperability by the end of the third quarter of 2020[67]. Additionally, Class I railroads define the USA's rail network landscape, given that they account for around 67% of freight rail mileage, 87% of freight employees, and 94% of freight revenue[68].

Furthermore, the USA's prescriptive standards not only govern the elements of the rail network related to interoperability, like in the EU, but instead cover several other regulatory areas such as safety and safe working, which remain a greater explicit focus than interoperability. Presently, prescriptive safety regulations on all American networks include the following:

- Track class.
- Speed.
- Underlying signalling system.
- Cab structure.
- Braking systems.

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59 US Department of Transportation Federal Railroad Administration. USA Perspective on Standards, Interoperability and Harmonization. Presentation Slides, 17 November 2023.

60 US Department of Transportation Federal Railroad Administration. USA Perspective on Standards, Interoperability and Harmonization. Presentation Slides, 17 November 2023.

61 Australian War Memorial. Australia under attack: Rail transport and Australia's war effort. N.d., https://www.awm.gov.au/visit/exhibitions/underattack/mobilise/rail.

62 US Department of Transportation Federal Railroad Administration. USA Perspective on Standards, Interoperability and Harmonization. Presentation Slides, 17 November 2023.

63 Transport Action Ontario. Enhanced Train Control for Canada's Railways. 2023. https://ontario.transportaction.ca/enhanced-train-control-for-canadas-railways/

64 Transport Action Ontario. Enhanced Train Control for Canada's Railways. 2023. https://ontario.transportaction.ca/enhanced-train-control-for-canadas-railways/

65 NOTE: There are no passenger train movements (and only very limited freight train movements) across the USA-Mexico border. However, this lack of volume is largely the result of political and economic drivers, as opposed to standards-related interoperability challenges.

66 Association of American Railroads (AAR). Freight Rail Facts & Figures. AAR, 2024.

67 Marsh, Joanna. US Class I railroads are almost fully interoperable. Freight Waves, 2020. https://www.freightwaves.com/news/us-class-i-railroads-are-almost-fully-interoperable.

68 Association of American Railroads (AAR). Freight Rail Facts & Figures. AAR, 2024.

- Couplers and physical interfaces.
- Safety appliances (including evacuation).
- Hours of service.
- Drug and alcohol testing[69].

Aside from prescriptive standards and regulations, American railroads are also governed by several performance-based regulations, which act like the performance-based regulations in Australia's RSNL. In America, these regulations cover several areas, including the following:

- Functional safety requirements.
- Configuration management.
- Design standards and human factors.
- Certification and crew size.
- Training and fatigue management.
- System safety and risk management.
- Future developments (including cybersecurity and rail energy/emissions)[70].

69 US Department of Transportation Federal Railroad Administration. USA Perspective on Standards, Interoperability and Harmonization. Presentation Slides, 17 November 2023.

70 US Department of Transportation Federal Railroad Administration. USA Perspective on Standards, Interoperability and Harmonization. Presentation Slides, 17 November 2023.

3. The Case for Standards Harmonisation

3.1 Methodology and Approach

The issue of rail standards harmonisation has been the subject of several Australian and international studies, which have all presented some variation of several core problems with non-harmonised standards environment, as well as key benefits of standardisation.

Instead of simply repackaging these previous studies, this Report presents an engagement-focussed methodology to understand the thinking on the 'case for standards harmonisation' in the current policy, operational, and technical environment. For determining current-state problems and future-state benefits, this approach is centred around the Investment Logic Mapping (ILM) workshop summarised in Table 3, as well as a series of external stakeholder engagement workshops with RIMs, RSOs, and rail equipment suppliers, which are outlined in the *Stakeholder Engagement Report* (Appendix A). These stakeholder workshops were also supplemented with targeted stakeholder interviews, as also outlined in the *Stakeholder Engagement Report* (Appendix A).

Table 3 Investment Logic Map Overview

Workshop Area	Investment Logic Mapping Description
Attendees	– ARA, NTC, ONRIC, and RISSB.
Purpose	– Develop a robust problem definition that describes the current issues to be addressed or opportunities that are not being captured. – Specify measurable benefits that are of high value to stakeholders. – Identify strategic responses to address the problems and realise the benefits.
Key discussion areas (from agenda)	– Problem / opportunity analysis. – Problem themes and priorities discussion. – Expected benefits. – Possible strategic responses.

3.2 Current State Problems and Future State Benefits

Based on the Problem Statements generated from the ILM workshop, external stakeholder workshops, and interviews (see the *Stakeholder Engagement Report* at Appendix A), as well as in the existing literature, several key problems were identified relating to the lack of standards harmonisation across Australia. Importantly, resolving these current state problems is associated with benefits to be achieved in a future state, noting that the full benefit might not be achieved, given that it is unlikely that 'total' harmonisation is technically or economically feasible or desirable. Indeed, although standards harmonisation is important in the Australian rail sector, harmonisation 'for its own sake' is not, and consideration must be given to what standards are harmonised and to what extent they are harmonised to achieve the identified benefits, without imposing unnecessary costs[71].

Ultimately, the problems and benefits from standards harmonisation relate to the following key areas, which are discussed and substantiated in the subsections below:

– Operational Interoperability.
– 'Economies of Scale' for Suppliers.

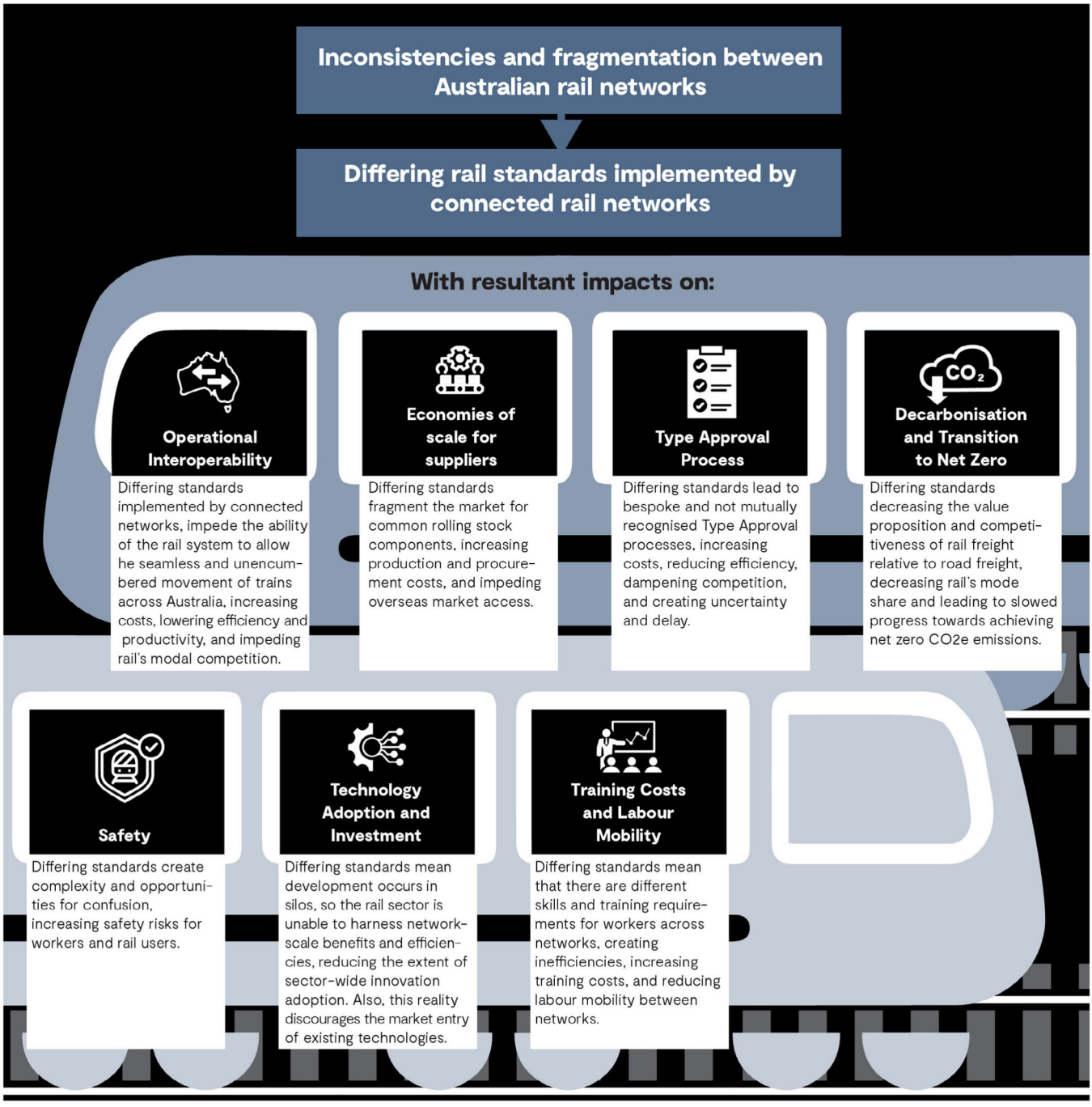
71 Bureau of Infrastructure and Transport Research Economics (BITRE). Optimising harmonisation in the Australian railway industry: report 114. BITRE, 2006. Chapter 2.

- Type Approval Process.
- Decarbonisation and Transition to Net Zero.
- Safety.
- Technology Adoption and Innovation.
- Training Costs and Labour Mobility.

Importantly, at their core, these identified problems all represent inefficiencies that are the consequence of the historical inconsistencies and fragmentation between different networks, which has substantially driven the variation in the rail standards used. Network inconsistency is the 'highest-level' problem of the lack of standards harmonisation in Australia, as it is the problem from which all other problems stem. It was the key, 'overarching', problem noted at the ILM workshop (see the *Stakeholder Engagement Report* at Appendix A).

A summary of 'the case for standards harmonisation', including a linkage between causes and effects, as well as a short description of the key benefits, is provided at Figure 7. The benefits of standards harmonisation are then discussed in the following subsections.

Figure 7 The Case for Standards Harmonisation – Summary



3.2.1 Operational Interoperability

Current State Problem

The 'interoperability' of railway networks, or the "ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance"[74] is determined by several factors including:

- Infrastructure specifications including for track, loading, and structure gauge.
- Signalling, communications, and control systems.
- Technical specifications including couplings, brakes, traction power, and kinematic envelope.
- Operating rules[75].

A note on track gauges:

Whilst not having a single national railway track gauge (see Figure 2) is occasionally referred to as the main reason for the lack of interoperability in the Australian rail network, it is by far not the nation's greatest rail interoperability challenge[72]. Indeed, Australia already has a standard gauge rail network that connects all mainland State capitals (see Section 2.1). This means that the financial case for gauge standardisation or other network infrastructure standardisation is weak, relative to the fragmented standards between networks[73].

Although interoperability does not require "sameness" or a singular way of operating, and instead only requires that potentially different systems are operationally compatible, Australia's patchwork of fragmented networks[76] still shows significant variations that limit interoperability[77].

While an important reason for the lack of interoperability of the Australian rail network is the existing physical network interfaces, including for track infrastructure such as platforms, bridges, and overhead line equipment (OLE)[78], the differing non-infrastructure standards implemented by connected networks also significantly inhibit interoperability. This lack of interoperability is important because it causes RSOs to bear significant 'bridging costs' to comply with the disparate standards of disparate yet adjacent networks to operate on them[79]. These bridging costs are ultimately passed on and borne throughout the supply chain; lowering rail sector efficiency and productivity, increasing costs, diminishing profit margins, raising barriers to entry, and lowering modal competition.

There are several examples of interoperability blockers across the Australian rail standards landscape, including in the following areas, among others:

- Signalling and control system standards.
- Radio communications system standards.
- Track and rolling stock standards.
- Traction standards.

Signalling and control system standards

Of the standards-related reasons for the lack of interoperability, one of the most consequential is the differences in signalling and control systems[80], of which there are 11 variations in use across Australia[81]. The different signalling systems being deployed on select networks are outlined in Table 4.

72 Australasian Railway Association (ARA). Interoperability & Regulatory Issues in Australian Rail Freight. ARA, 2021. Pg., 7.

73 Bureau of Infrastructure and Transport Research Economics (BITRE). Optimising harmonisation in the Australian railway industry: report 114. BITRE, 2006. Pg., v, xxiii.

74 Directive (EU) 2016/797

75 Rail Industry Safety and Standards Board (RISSB). Rail Systems Interoperability Guidelines. 2015. Pg., 5.

76 NOTE: This excludes the interstate main lines and some compatible ancillary networks.

77 Rail Industry Safety and Standards Board (RISSB). Rail Systems Interoperability Guidelines. 2015. Pg., 24.

78 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 8.

79 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Overview. Palazzi Rail (for RISSB), 2022. Pg., 4.

80 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Explanatory paper. Palazzi Rail (for RISSB), 2022. Pg., 11.

81 National Transport Commission (NTC). National Rail Action Plan. NTC. Pg., 6

Table 4 Select range of differing signalling standards are being deployed[82]

Signalling standard	MCA Score
European Train Control System (ETCS)	– Sydney Trains. – QR Citytrain. – Adelaide Metro.
Communications Based Train Control (CBTC)	– Sydney Metro. – Metro Tunnel (Melbourne). – TransPerth.
Computer-based Train Order Working	– ARTC – NSW regional network. – UGL Regional Linx.
Electronic Train Order Working	– V/Line.
Direct Train Control	– QR regional branch lines.
(Multiple different systems)	– ARTC – Defined Interstate Rail Network (DIRN).

Importantly, these systems are generally incompatible with one another, meaning that they constitute one of the most significant digital or operational 'breaks-of-gauge' in the nation[83]. Rather than all locomotives being fitted with a single signalling and control system, multiple radios are required instead, or multiple radios that are integrated into a single, expensive, device. Additionally, in the future, there is the potential for locomotives operating on multiple networks to need to be fitted with multiple technology sub-systems, to comply with all standards requirements simultaneously[84].

Put simply, the use of multiple signalling and control system standards leads to extensive bridging costs for what is, in effect, a duplication of technology (and related training) that serves the same purpose and that would not be needed if a single, nationally harmonised, system was in place[85]. This disparity also imposes additional duplication costs for management, maintenance, and competency training for both RIMs and RSOs[86]. Finally, the legacy costs of building bespoke versions of international systems (such as ETCS) limits Australia's capacity to benefit from future developments of these systems.

Human factor issues caused by this duplication also pose safety concerns, as outlined in Section 3.2.5.

Radio communications system standards.

Aside from signalling and control systems, Australia's States also use radio communications systems that are incompatible with each other[87]. This means that trains crossing Australia using the inter-state standard gauge network typically require five or six sets of radio equipment to be interoperable, adding to the duplicating bridging costs needed to operate across networks[88]. There is also limited room in locomotives to physically comply with the requirements for multiple, duplicated systems such as radios[89]. This also poses a safety concern, as outlined in Section 3.2.5[90].

82 Cited in: Engineers Australia. Future of Rail Transport: A Transport Australia Society Discussion Paper. Engineers Australia, 2022. Pg., 12.

83 Australasian Railway Association (ARA). Interoperability & Regulatory Issues in Australian Rail Freight. ARA, 2021. Pg., 13.

84 NOTE: Although not related to operational interoperability, the need to cater for additional future (often unknown) systems in any new locomotive build is difficult and expensive. Additionally, any retrofitting of technology into existing locos is also very expensive, and sometimes simply not possible.

85 SYSTRA. Interoperability: The fast track to a seamless, safer railway system. SYSTRA ANZ, 2023. Pg., 6.

86 National Transport Commission (NTC). National Rail Action Plan. NTC. Pg., 6

87 Australasian Railway Association (ARA). Interoperability & Regulatory Issues in Australian Rail Freight. ARA, 2021. Pg., 4.

88 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 31.

89 See: Stakeholder Engagement Report (Appendix A).

90 NOTE: To some extent, the alignment of incompatible field systems is occurring through the In-Cab Communications Equipment (ICE) radio system, which provides a single interface for multiple radio systems.

Track and rolling stock standards.

The legacy of different track and rolling stock standards applied by different RIMs mean that RSOs rolling stock suboptimal design and performance capability to cater for varying standards, even if the nature of the track is similar. This is exacerbated by complex, differing, and uncertain certification and approval processes, which also impede innovation and the adoption of newer, more efficient technologies. This lack of interoperability for rolling stock means that RSOs and other rolling stock owners cannot get maximum asset performance and require more trains, staff, and other resources to achieve the same transport and logistics outcomes. This represents a costly inefficiency and drain on productivity[91]. The uncertain approval process also creates a barrier to innovation, including for decarbonisation-related technologies (see Section 3.2.6)

Traction standards

Different AC and DC traction standards between networks cause costly delays. Indeed, while an AC locomotive can lead on some networks, it cannot lead on other networks, requiring remarshalling. This remarshalling can lead to inefficient delays in the train schedule as the process is time-consuming. Additionally, it can pose safety risks to the crew involved in the process. An example of this need for remarshalling is for trains coming from the ARTC network, where AC traction trains can lead, to the Sydney Trains network, where they cannot[92]. Of note, different traction standards also have economies of scale and net zero implications (see Sections 3.2.2 and 3.2.4 respectively).

The combined impact of the lack of interoperability on rail costs, due to negative efficiency and productivity impacts, is likely significant. In 1999, before major improvements in interoperability had been made (see Section 2.3.1), the EU's MINIMISE[93] project estimated that the annual net benefit of addressing Europe's interoperability barriers was €1.4 billion for rail freight and €1.3 billion for passenger rail (in 1999 Euros, uninflated)[94]. The 2012 Taig Review similarly concluded that, broadly defined, harmonisation "adds somewhere between a few % and a few 10's of % to the cost of railway goods and services in Australia, and potentially substantially more where interoperability is at issue"[95].

Future State Benefit

Rail standards harmonisation, especially in key areas such as signalling and control system standards, would foster technical and operational interoperability[96]. Importantly, this increased interoperability would mean that freight and passenger rail could move more seamlessly between major cities and regions on a modern, integrated, and productive and operationally efficient national network.

Currently, trains transport only 14% of domestic non-bulk freight, down from 25% in 1975[97]. However, improved efficiency and competitiveness would likely increase this proportion of non-bulk freight. Indeed, interoperability would breed smoother and more efficient movement and performance. This would reduce transit times, lower costs for both consumers and businesses across Australia's major cities and major freight routes, as well as increase rail sector competitiveness and attract investment[98]. It would also improve the flow of exports through more efficient and uninterrupted connections to ports[99].

In the USA, which has far greater operational interoperability, freight railroads account for approximately 40% of U.S. long-distance freight volume (measured by ton-miles), which is more than any other mode of transportation[100]. In Europe, where the comparatively short-haul nature of most freight transport (as opposed to Australia) makes rail inherently less competitive to road alternatives, estimated freight rail mode share is still higher than Australia, averaging approximately 20% over the past 15 years[101].

The efficiency and productivity gains of increased operational interoperability in Australia would be felt throughout the supply chain, with productivity improvements across network boundaries that decrease costs (see Figure 8 which is demonstrative only), increase mode competitiveness and modal shift towards rail (see Section 3.2.4), and drive wider economic growth[102].

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91 See: Stakeholder Engagement Report (Appendix A).

92 See: Stakeholder Engagement Report (Appendix A).

93 "Managing Interoperability by Improvements in Transport System Organisation in Europe".

94 Cited in: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 8.

95 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 13.

96 EULYNX. Digitalisation and Standardisation of Signalling Systems with EULYNX. Presentation Slides, 17 November 2023.

97 Bureau of Infrastructure and Transport Research Economics (BITRE). Australian Infrastructure and Transport Statistics Yearbook 2023. BITRE, 2023. Table 4.1b Domestic freight by transport mode – non-bulk. Pg., 89.

98 Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

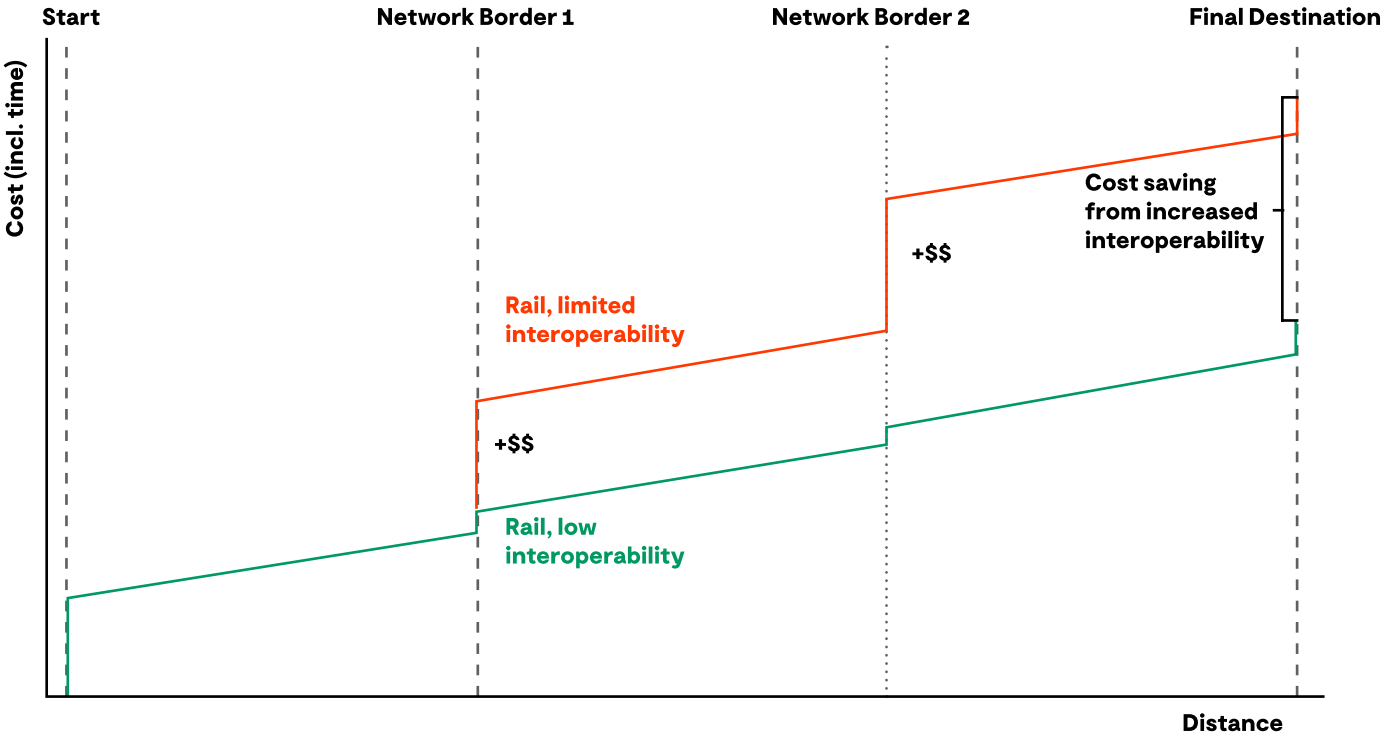
99 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Explanatory paper. Palazzi Rail (for RISSB), 2022. Pg., 15.

100 Association of American Railroads. N.d., Data Centre. https://www.aar.org/data-center/.

101 International Union of Railways (UIC). 2023. The modal share of rail in inland transport and infrastructure investment. Pg., 2

102 SYSTRA. Interoperability: The fast track to a seamless, safer railway system. SYSTRA ANZ, 2023. Pg., 7.

Figure 8 Illustrative impact of increased interoperability on rail sector supply chain costs[103]



Increased interoperability between Australian networks would work to streamline rail transportation, stimulating investment and economic development, particularly in outlying regions, by opening new markets and job possibilities. Indeed, improved interoperability would better allow regional businesses to connect with employees, resources for production, and distribution networks, thereby assisting their development into regional centres[104].

In this light, the Taig Review concluded that the "economic benefits of greater harmonisation could be particularly great; of order several % to a few 10's of % of the $10B scale annual expenditure on railways across Australia"[105]. Similarly, Di Pietrantonio et al. (2004) evaluated the economic impact of interoperability in the EU prior to the bloc's standard harmonisation drive and the implementation of TSIs. This research estimated that the "total cost savings due to fully-fledged interoperability and a higher degree of technical harmonisation could be in the order of 30-40 per cent on the total value chain costs"[106].

Also, interoperability enhances network resilience, providing a robust solution to potential disruptions. When rolling stock are interoperable, they can operate across different network sections and railway systems, thereby offering more options during disruptions. This flexibility allows for the rerouting of trains through alternative paths, where this is possible within Australian rail networks, works to ensure continuous service despite localised issues. It also facilitates the sharing of resources between different network sections. Furthermore, interoperability reduces dependency on a single route or service, thereby decreasing the risk of network-wide shutdowns[107].

3.2.2 'Economies of Scale' for Suppliers

Economies of scale:
"The reduction in the average cost of production, and hence in the unit costs, when output of the same good is increased".

Current State Problem

Given the size of the Australian rail sector, the domestic market for rolling stock is small compared to international markets such as the EU and the USA. However, this size disparity is further exacerbated by the uncoordinated and inconsistent procurement cycles of Australia's fragmented RIM-based procurement agencies, as well as the varying standards between networks, with negative economic effects[108].

103 GHD, 2024. Adapted from: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023.

104 Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

105 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 44.

106 Cited in: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 22.

107 NOTE: Although this is still a concern in Australia, it is less of a concern when compared to other rail systems such as the EU, there are limited alternative corridors in Australia.

108 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 19.

While some of the variation in rolling stock specifications persists because of different infrastructure interfaces, particularly bogies and car bodies (i.e., loading gauge and envelope), and, as such, will necessarily and persistently fragment the market, this is not the case for all rolling stock standards. Indeed, some differing standards (i.e., differing standards for glazing) implemented by RIMs and RSOs further fragment the market for common rolling stock components into even smaller markets than are technically or practically required, imposing niche and network-specific requirements on rail equipment suppliers. This increased fragmentation means that suppliers must tailor the design and manufacture of their products to unique standards, which increases the cost of production through an inverse 'economy of scale' effect, reducing the viability of cost-effective local manufacturing, with access to some 'bespoke' networks becoming financially unattractive[109].

Put differently, RIMs and RSOs specify unique standards for train components and systems, which makes it difficult or impossible for rail equipment suppliers to standardise their production and reduce costs from an economy of scale perspective. This result has potentially limited rail equipment suppliers' abilities to expand their Australian footprint as well as access wider domestic and global markets[110]. Australian manufacturing competitiveness may have been eroded by the absence of scale market opportunities[111]. Select examples of different standards, and how they fragment the rail equipment supply industry, are presented in Table 5.

Table 5 Select examples of different rail manufacturing standards across Australia[112]

Name of Standard	Divergence and Fragmentation	National or International Divergence	Cost of Anomaly
Seating	There are differences between RSOs, and some RSOs even have different seating within their own fleets.	Both	High
HVAC	There are differences between HVAC in cabs and HVAC in carriages. Some HVAC is made overseas and modified for Australia, but some is made here. If it were made to international specifications, it could be sold overseas.	Both	High
Internal passenger information and communication systems	There is significant variation in digital voice, information displays, Wi-Fi, and portable charging requirements between networks.	National [113]	Medium

Importantly, this increased cost of production also increases the price paid by rolling stock procurement agencies. This is because the increases in the cost of production through the need to tailor rolling stock products are passed onto rolling stock consumers[114], and the fragmented market structure limits competition between suppliers to a specific network.

Fragmented procurement also limits options to trade assets to different RSOs, whether to address short-term needs or at end of life, as well as increases the risk of stranded assets when maintenance contracts end. This standard asset risks exists because it is not economically beneficial for suppliers to continue the production of a bespoke rolling stock or critical components beyond their contractual obligations, working to create a higher probability of product obsolescence.

Counterpoint: The upsides of customisation

While the fragmentation outlined in this section does come with clear negative economies of scale effects, it is important to note that there are some upsides of tailoring to local needs. These include the potential for custom solutions to network-specific problems, such as ensuring local intermodal interoperability. Suppliers can also compete on customisation, driving the development of innovative solutions.

109 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 19.

110 Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

111 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 15.

112 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 9-10. Adapted and presented by GHD.

113 NOTE: National only, as over-arching Australian Standards (outside of rail specifically), in this case DSAPT, may drive divergence from international standards and cannot be avoided.

114 National Transport Commission (NTC). National Rail Action Plan. NTC. Pg., 6.

The impact of the bespoke orders, small batch sizes, and lack of national co-ordination in rail procurement, is estimated to incur a 30% price premium paid by rolling stock procurement agencies in Australia[115]. An EU study also estimated that, at the margins, a reduction in rolling stock design costs between 5 to 10%, which could be achieved through the removal of network-specific standards that require bespoke design, could deliver a 20 to 30% reduction in rolling stock replacement costs over the 20-year time horizon[116]. In addition to the price premium for procurement agencies, these same factors erode the potential for greater local manufacturing of components.

Future State Benefit

Increased Economies of Scale

If the appropriate rail standards are harmonised across Australia, it will increase economies of scale impacts for rail equipment suppliers, which will result in longer production runs that reduce the costs of manufacturing and maintenance, as well as encourage domestic production by allowing Australian-made components to be more competitive in local and overseas markets[117]. There can also be a consolidation of manufacturing facilities and further investment in site technology with economies of scale.

Importantly, economies of scale that reduce costs through increased efficiency will also aid the long-term sustainability and capability of the domestic rail equipment supply industry, as well as encourage foreign direct investment and new market entry from established brands operating overseas[118]. Importantly, cost savings are particularly significant in the context of the low profit margins of market participants in the Australian rolling stock supply industry (which have been estimated to be as low as 4%[119]), meaning that any efficiencies significantly help improve a given domestic manufacturer's commercial viability.

Additionally, the reduced costs, more efficient production, and greater competition of the rail supply industry, because of harmonised standards, would deliver better value for money for rolling stock procurement agencies[120]. This outcome would also support an innovative rail sector in Australia, by encouraging the 'pull-through' in the innovation system from research to production[121].

The efficiency benefits possible from a more harmonised approach to rail manufacturing, have also been seen in the introduction of a more harmonised approach to identifying, tracking, and maintaining rail assets, parts, and components in the rail supply chain, through Project i-TRACE. Indeed, Project i-TRACE was initiated in 2017 by the rail industry, via the ARA, using ISO certified GS1 global data standards to provide a single language to be used by all stakeholders in the rail supply chain. It has led to greater efficiency and productivity, as well as lower costs across the supply chain, by digitising inventory management, automating all steps in the supply chain and providing critical information throughout the life cycle of a product, part or component; highlighting the benefit of using a single common 'language' (i.e., set of standards)[122].

Improved Supply Chain Stability

Increasing domestically manufactured rolling stock components simplifies the supply chain, thereby reducing dependency on international suppliers and mitigating the risks associated with geopolitical tensions, trade disputes, and global shipping disruptions.

Presently, with such a small market, Australia is typically at the back of the line for major international suppliers, with RSOs waiting extended periods for long-lead spare parts, which reduces up-time for rolling stock assets and can impact their operations and profitability. This was especially pronounced following the COVID-19 pandemic, where several rolling stock procurement agencies experienced major delays in sourcing some components[123]. In this context, increasing domestically manufactured rolling stock components allows for quicker response times to changes in demand or supply shocks, fostering adaptability and stability.

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115 Deloitte Access, cited in: Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

116 European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 9.

117 National Transport Commission (NTC). National Rail Action Plan. NTC. Pg., 13.

118 Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

119 Jones, Roger, Sidney Lung, and Celeste Young. Reimagining the workforce: the economics of rolling stock manufacturing, maintenance, and operations for Victoria's public transport sector. Rail Manufacturing Cooperative Research Centre, 2020.

120 Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

121 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 35.

122 Australasian Railway Association (ARA). Project i-TRACE. N.d., https://ara.net.au/priorities/technology/project-i-trace/.

123 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 42.

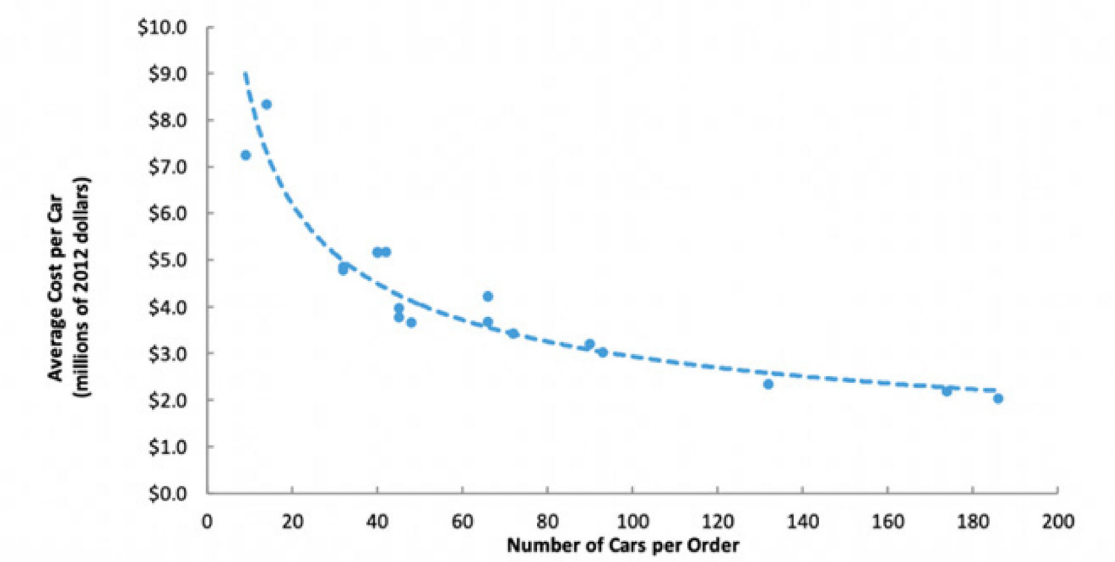
The alignment of Australian standards to those in European or other international standards has the additional advantage of encouraging domestic manufacturers to sell their products in those international markets[124]. Indeed, harmonised standards for Australian rolling stock procurement that are aligned with international standards such as UIC, ISO, EN, or BS, would establish a realistic ability for domestic rail equipment suppliers to participate in export markets and grow their role in the international rail supply chain[125].

Existing Empirical Studies

There are several existing empirical studies on the magnitude of the impact of economies of scale effects for rail equipment suppliers. These are as follows:

- The European Union's MODTRAIN[126] project, sought to develop collaborative open standards for all aspects of train design. It had a focus on common manufacturing standards and designs, specifically a modular design and reduction in parts employed in the build process. The project reported a 15% reduction in manufacturing costs[127].
- A BIS Oxford Economics and Hadron Group (2023) report for the ARA on the benefits of a national local content policy, estimated the foregone procurement cost savings from a lack of policy harmonisation (including standards harmonisation) over the pre-ceding decade (12 contracts and 3,061 cars) at $1.85 billion. Of this figure, $717 million of savings is from increased scale, $811 million of savings from reduced complexity in planning and design, and $318 million of savings is from major componentry harmonisation[128]. The analysis also concluded that, if this $1.85 billion cost saving had been invested in health and education it would have directly supported 1530 workers across the decade and contributed to $4.69 billion of revenue and $2.79 billion of gross state product[129].
- Nine Squared (2022) analysis estimated that the average cost per car for a single-deck passenger train decreases by 35% to 40% when ordering 60 rather than 20 at once. This result illustrates that there are significant savings when moving from small orders of components to mid-sized orders, which is an outcome that is enabled by the broad harmonisation of components[130].
- Deloitte Access Economics (2013) estimated that the annual available productivity gain of reforming the fragmented Australian public transport rail manufacturing is approximately 19%. This analysis considered harmonised and smoothed production levels as well as reduced heterogeneity. Further, this study illustrated the impact on rolling stock costs of moving from small to larger orders (Figure 9), which is enabled by standards harmonisation[131].

Figure 9 Economies of scale decrease in rolling stock cost from larger order sizes



124 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 9.

125 Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

126 "Innovative modular vehicle concepts for an integrated European railway system".

127 European Union. On Track to a Sustainable Future: EU-funded research for a safe and efficient European Rail system. 2010. Pg.,16.

128 BIS Oxford Economics and Hadron Group. Benefits of a National Local Content Policy. ARA, 2023. Pg., 3.

129 BIS Oxford Economics and Hadron Group. Benefits of a National Local Content Policy. ARA, 2023. Pg., 7.

130 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 27.

131 Deloitte Access Economics. Greater Passenger Rolling Stock Procurement Efficiency. Deloitte, 2013.

- Modelling in the AMWU (2017) submission to the Senate Reference Committee on Rail Industry assumed a case of 30% productivity gains in rail manufacturing from standards harmonisation and a base case of 25%[132]. This was supported by the submission's broad stakeholder engagement[133].
- Nine Squared (2022) Input-Output (IO) modelled benefits assessment of five key common standards found that the potential impact on the Australian economy from the manufacturing of the five components locally for passenger rolling stock, may approach $317 million in output and directly and indirectly support 913 FTE positions. This is an outcome supported by harmonised standards[134].

Stakeholder Input:

At the rail equipment suppliers' workshop, attendees noted that harmonised standards can help increase economies of scale in production. Standardised processes and components can streamline manufacturing and maintenance, leading to more efficient production lines and a reduction in the time-to-market for new technologies. By increasing economies of scale and reducing the need for customised solutions for different networks, costs associated with the manufacturing and procurement of rail equipment can be reduced. Attendees agreed that harmonisation would also level the playing field by removing barriers to market entry, thereby enabling increased competition.

Additionally, suppliers also noted that there are reduced opportunities for Australian suppliers to sell to international markets due to the increased cost of production. Attendees identified that a harmonised set of standards can help reduce the need for customised solutions for networks, thus lowering the overall costs associated with manufacturing and procurement of rail equipment. Importantly, these reduced costs of production can also be passed on as cost savings for the end consumer (i.e., RIMs who are procuring equipment).

3.2.3 Type Approval Process

Current State Problem

Every railway authority in Australia has a unique Type Approval (TA) process to review and approve products to be used on their network. This exacerbates the already-challenging issues associated with having different standards, operating rules, and communication and control systems for each network. Additionally, there is also little to no mutual recognition of products, nor a common approach to dealing with exceptions and non-compliances. This adds costs, reduces efficiency, dampens competition, and creates uncertainty.[136]

Type Approval (TA):

"Approval of a specific item or product of railway equipment, demonstrating so far as is reasonably practicable (SFAIRP) that it is fit for purpose for a defined application meeting the requirements as applicable to the network". [135]

In the current state, a rail equipment supplier must undergo a different TA process for each network they want to supply any given product, including rolling stock, resulting in a costly duplication of the approvals process. This duplication across networks means that resources are wasted on a process that has often already occurred for a similar network, not only increasing regulatory burden but also creating backlogs and delays in procurement pipelines[137]. Inefficiencies are further exacerbated because TA processes vary between networks, because of the different standards regimes governing networks, which means learnings from one network process might not necessarily be transferrable to another[138].

The incidence of the direct and potentially duplicated costs incurred by suppliers, 'sponsors'[139], and approving entities (such as RIMs) in the TA process are provided at Table 6. Note that while there are likely some scale effects decreasing the cost of a TA application with every application completed (because of some degree of repetition in the process between jurisdictions), some element of each cost identified would be duplicated for a product approved on one network, to then be approved on another.

132 Australian Manufacturing Workers' Union (AMWU). Reforms to save our public transport rail manufacturing sector. AMWU, 2016. Pg., 14.
133 Australian Manufacturing Workers' Union (AMWU). Reforms to save our public transport rail manufacturing sector. AMWU, 2016. Pg., 14.
134 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 8.
135 RISSB AS7702 Railway Equipment Type Approval.
136 Australasian Railway Association (ARA). Interoperability & Regulatory Issues in Australian Rail Freight. ARA, 2021. Pg., 2.
137 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 48.
138 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 48.
139 NOTE: The 'sponsor' is typically a rail construction project contractor, rail operator, or infrastructure owner, which is the prospective customer, to support or champion its product.

Table 6 Summary of direct costs incurred by stage of TA process[140]

TA Stage	Rail Equipment Supplier	Sponsor	Approving Entity
Pre-application	– Establishing local presence (incl. market engagement). – Establishing a relationship with prospective sponsor.	– Internal staff costs.	– Nil
Stage 1 – Application preparation	– Internal staff costs (incl. engineers, technicians, design personnel). – Internal product testing and preparation of documentation. – Laboratory testing and trialling costs.	– Internal staff costs (incl. communicating with supplier and approving entity, reviewing supplier documentation). – Preparation of studies and documentation of results.	– Internal staff costs (incl. liaising with supplier on TA requirements).
Stage 2 – Assessment by approving entity	– Liaise with Sponsor.	– Internal staff costs (communicating with supplier and approving entity). – Preparation of studies and documentation of results.	– Internal staff costs – reviewing application, liaising with supplier on additional requirements. – Reviewing outcomes from studies/trials.
Stage 3 – Post-approval and ongoing monitoring	– Liaise with Sponsor.	– Internal staff costs (incl. communicating with supplier and approving entity).	– Granting of final TA approval

Aside from the duplication costs for TA requirements across different networks, the lack of harmonised standards also makes it sometimes prohibitively difficult to obtain TA for new products and technologies, constraining competition, and technology adoption[141]. This includes products and technologies that are already common practice in other networks and overseas[142]. Indeed, the fragmentation of rail markets and divergent standards regimes for rolling stock and other technologies, largely by increasing costs and required effort, acts as a deterrent to investment and progress in technical advancement across Australia[143]. The first mover for technological development is impeded, discouraging innovation. Instead, RSOs are incentivised to use already type approved assets, which are often inferior in terms of quality, emissions, and safety.

This constrained adoption of new technologies is working to increase the age of rolling stock across Australia, as RSOs often must use old locomotives due to a lack of availability for commercially attractive newer alternatives[144]. The 'older' age of Australia's locomotive fleet is illustrated in the cumulative age profile in Figure 10.

140 Adapted and presented by GHD from: Synergies. Estimating the economic cost of Type Approval processes in the Australian rail industry. Synergies Economic Consulting (for ARA and RISSB). 2022. Pg., 24-25 (Table 1).

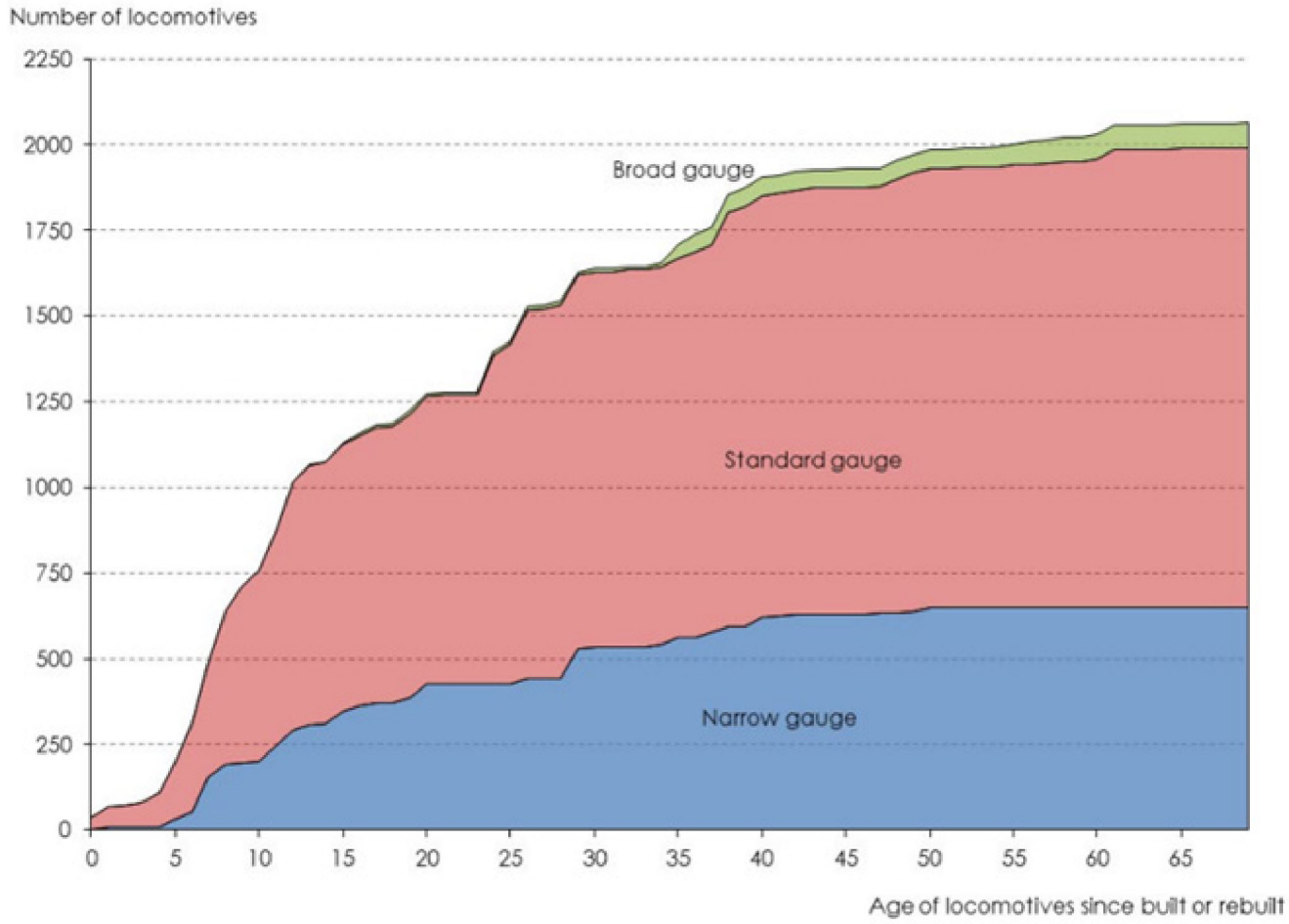
141 Synergies. Estimating the economic cost of Type Approval processes in the Australian rail industry. Synergies Economic Consulting (for ARA and RISSB). 2022. Pg., 2.

142 See: Stakeholder Engagement Report (Appendix A).

143 Rural and Regional Affairs and Transport References Committee. State of Australia's rail industry. 2016, Pg., 8.

144 Bureau of Infrastructure and Transport Research Economics (BITRE) and Australasian Railway Association (ARA). Trainline 8 Statistical Report. BITRE and ARA, 2021. Pg., 70.

Figure 10 Cumulative locomotive age profile, by number of locomotives[145]



Further, the direct cost of processing TAs in Australia has been estimated at approximately $230 million per annum[146]. The bulk of these costs are driven by the additional trialling requirements associated with securing approval for major products and technologies across a multitude of networks. Additionally, for both of minor and major TAs, the bulk of these costs (over 70%) are incurred by the rail equipment supplier, acting as a direct restriction on the supplier bringing a product to the Australian market[147].

The indirect costs of TA inefficiency in Australia, in the form of the opportunity costs and adverse impact on long-term productivity, can be attributed to the significant constraint that the current TA framework imposes on competition and innovation in the rail sector. These costs are also likely to be significantly greater in magnitude than the quantified direct costs. [148]

Although there are currently important initiatives aiming to standardise the TA process, such as the joint TfNSW and DTP Victoria Product Type Approval Framework[149], this trial is in the early stages and focused on only 17 products across road and rail.

Future State Benefit

By adopting harmonised standards leading to increasing uniformity and mutual recognition for TA processes across networks, the rail sector could decrease the extent of costly and time-consuming duplication. This would reduce the compliance burden for not only rail equipment suppliers, but also RSOs, sponsors, and the evaluating entities.

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145 Bureau of Infrastructure and Transport Research Economics (BITRE) and Australasian Railway Association (ARA). Trainline 8 Statistical Report. BITRE and ARA, 2021. Pg., 71 (Figure 34).

146 Synergies. Estimating the economic cost of Type Approval processes in the Australian rail industry. Synergies Economic Consulting (for ARA and RISSB). 2022. Pg., 3.

147 Synergies. Estimating the economic cost of Type Approval processes in the Australian rail industry. Synergies Economic Consulting (for ARA and RISSB). 2022. Pg., 28-29.

148 Synergies. Estimating the economic cost of Type Approval processes in the Australian rail industry. Synergies Economic Consulting (for ARA and RISSB). 2022. Pg., 4.

149 Transport for NSW (TfNSW). Product Type Approval Framework. 2023. TfNSW. https://www.transport.nsw.gov.au/industry/asset-management-branch/product-type-approval-framework.

Suppliers would no longer need to undergo a unique TA process for each network they wish to supply, especially for proven technologies operating on other networks, thereby reducing redundant regulatory burdens and expediting procurement pipelines. This could lead to substantial cost savings throughout the sector, especially considering the indirect costs associated with lost opportunities and productivity.

It's important to note that the exact amount of cost savings from eliminating the TA duplication across different networks would hinge on the extent of harmonisation that is implemented and the consistency level attained across the TA processes. Moreover, there are some areas of apparent duplication that are justified, in which case it would be undesirable to reach a 100% cost reduction. However, stakeholders consulted during the *Estimating the economic cost of Type Approval processes in the Australian rail industry* (2022) report indicated that over 50% of the current TA direct costs that relate to technical aspects could be avoided, indicating a cost saving of over $40 million per annum[150]. The benefit of standards harmonisation to the TA process has also been observed internationally. Indeed, in an EU study from 2012, it was estimated that the application of the TSIs to the entire EU rail network could result in €40 million annually (uninflated) in cost savings for locomotive authorisation alone, primarily benefitting domestic rail equipment suppliers[151]. Also considering progress with harmonisation of the process for TA, it was estimated that per annum costs for authorisations of locomotives could be more than halved compared to a pre-TSI 2011 baseline, equating to €300 million annually.[152]

Stakeholder Input:

At the rail equipment suppliers' workshop, attendees noted that type approvals for products can be a multi-year and costly process. Even in cases where products have been proven in the EU, the implementation and approval for use on Australian networks remains a costly and lengthy process. Currently, there is significant difficulty in ensuring value for money while procuring equipment due to the limited number of international products that are type approved on Australian networks. Attendees identified that there are multiple cost-effective suppliers who are not able to profitably sell to Australia due to the costs associated with the Type Approval process, and even if their products are already type approved in the EU.

3.2.4 Decarbonisation and Transition to Net Zero

Current State Problem

The transition to net-zero emissions is a time-critical endeavour that requires immediate and sustained action. The longer that Australia delays reducing greenhouse gas emissions, the more drastic and potentially disruptive the required changes will be to achieve the net-zero target. Therefore, it is imperative to act now and make consistent progress to ensure a smooth, equitable, and sustainable transition to a net-zero future.

Importantly in this context, rail freight, on average, produces 16 times less carbon dioxide pollution than road freight per tonne-kilometre travelled[153]. Therefore, increasing rail freight mode share is beneficial for decarbonising and reducing general energy consumption in the freight transport sector as part of a broader, economy-wide, net zero transition[154]. However, rail freight's mode share is currently low and on the opposite trajectory.

While domestic interstate non-bulk rail freight has increased from around 4.7 billion tonne-kilometres in 1971–72 to around 24.0 billion tonne-kilometres in 2019–20 (a 511% increase)[155], total road freight has increased from around 27 billion tonne-kilometres in 1970–71 to around 223 billion tonne-kilometres in 2019–20 (a larger, 826% increase)[156]. This trend also masks the collapse of rail freight on some key interstate markets, such as between Melbourne and Sydney. For this route, just 2% of freight is on rail, which is down from 40% in the 1970s.[157]

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150 Synergies. Estimating the economic cost of Type Approval processes in the Australian rail industry. Synergies Economic Consulting (for ARA and RISSB). 2022. Pg., 39.

151 Cited in: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 15.

152 Cited in: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 15.

153 Deloitte Access Economics (DAE). Value of Rail 2020: The rail industry's contribution to a strong economy and vibrant communities. DAE (for ARA), 2020. Pg., 50.

154 NOTE: Aside from lower carbon supply chains, increased rail freight mode share would reduce the social costs associated through with road accidents and congestion, as well as the health costs of emissions.

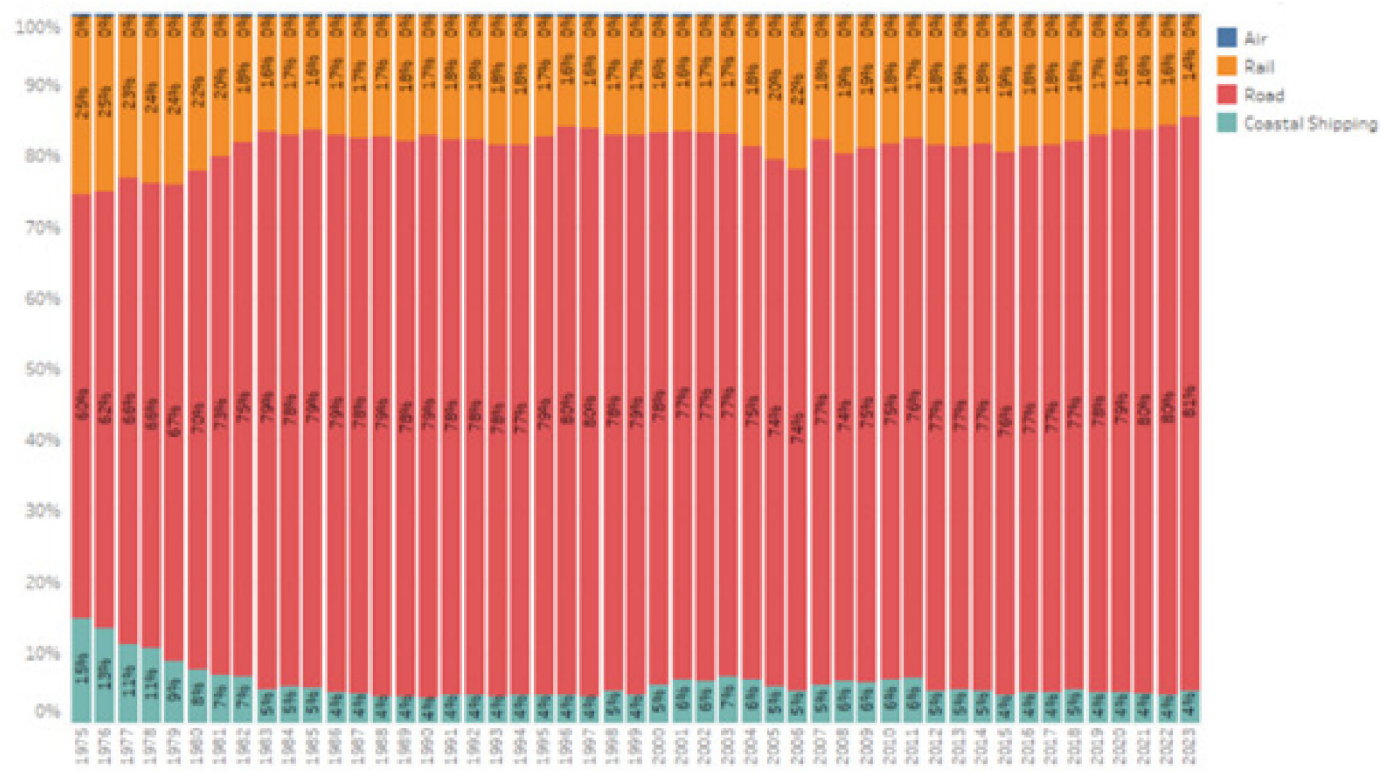
155 Bureau of Infrastructure and Transport Research Economics (BITRE). Australian aggregate freight forecasts – 2022 update: report 154. BITRE, 2022. Pg., 28.

156 Bureau of Infrastructure and Transport Research Economics (BITRE). Australian aggregate freight forecasts – 2022 update: report 154. BITRE, 2022. Pg., 5.

157 Cited in: Visontay, Elias. Only 2% of freight between Melbourne and Sydney goes by rail – putting Australia's emissions targets at risk. The Guardian, 2 November 2023. https://www.theguardian.com/australia-news/2023/nov/02/dwindling-use-of-rail-freight-puts-australias-emissions-targets-at-risk-industry-warns

In 1975, trains transported 25% of domestic non-bulk freight in Australia by tonne-kilometres, while trucks took 60%. However, by 2023, trains transported only 14% of domestic non-bulk freight, with trucks taking 81%[158]. This trend towards decreasing non-bulk domestic rail freight mode share is illustrated in Figure 11.

Figure 11 Australian non-bulk domestic freight mode share of tonne-kilometres[159]



Importantly, the lack or absence of interoperability across rail networks, largely because of a lack of standards harmonisation, increases the operating costs of rail freight, reducing operational flexibility, and impeding the ability of the rail sector to compete with other more emissions-intensive transport modes such as road freight[160]. Indeed, the operational inefficiencies following from non-interoperability contribute to the fact that the time and costs needed for rail freight transport are greater (see Section 3.2.1), decreasing the value proposition and competitiveness of rail freight relative to road freight, and leading to a decrease in rail freight mode share and higher levels of emissions. [161]

In contrast to rail, the road freight sector has none of the same interoperability issues of the rail sector. Indeed, road freight is far more flexible and less infrastructure dependent, because it can utilise a vast network of roads and highways across State boarders, which allow for direct, door-to-door service. Additionally, since 2014, the National Heavy Vehicle Regulator (NHVR) has administered one set of laws national laws for road freight vehicles over 4.5 tonnes of gross vehicle mass. This set of laws consists of the Heavy Vehicle National Law (HVNL) and five sets of regulations[162]. Under the framework provided by the NHVR and other relevant regulations, which was first enacted in Queensland in 2012, there are little to none of the cost-increasing duplications and inefficiencies seen in the rail sector. Instead, a heavy vehicle can travel from one capital city to another using one licence and registration, one radio, and almost completely consistent operating (road) rules.

The cost of the inefficiency generated by non-seamless rail transport across network borders, relative to road freight, is illustrated for effect in Figure 12 (which is demonstrative only, illustrating that although rail could be the more cost-efficient mode over longer distances, it isn't because of interoperability challenges, among other things). It is the cost dynamics illustrated in Figure 12 of rail freight relative to road freight, which is likely contributing to a lower rail freight

158 NOTE: While there are several explanations of this decline, a key reason is that a greater proportion of rail services were operated on self-contained networks in the 1970s compared to now. However, with the closure of many regional lines on these self-networks, many more of the tonne-kms operated on cross-network services, which are subject to the (Standards related) interoperability challenges identified in this Report.

159 Adapted by chartingtransport.com from: Bureau of Infrastructure and Transport Research Economics (BITRE). Australian Infrastructure and Transport Statistics Yearbook 2023. BITRE, 2023. Table 4.1b Domestic freight by transport mode – non-bulk. Pg., 89.

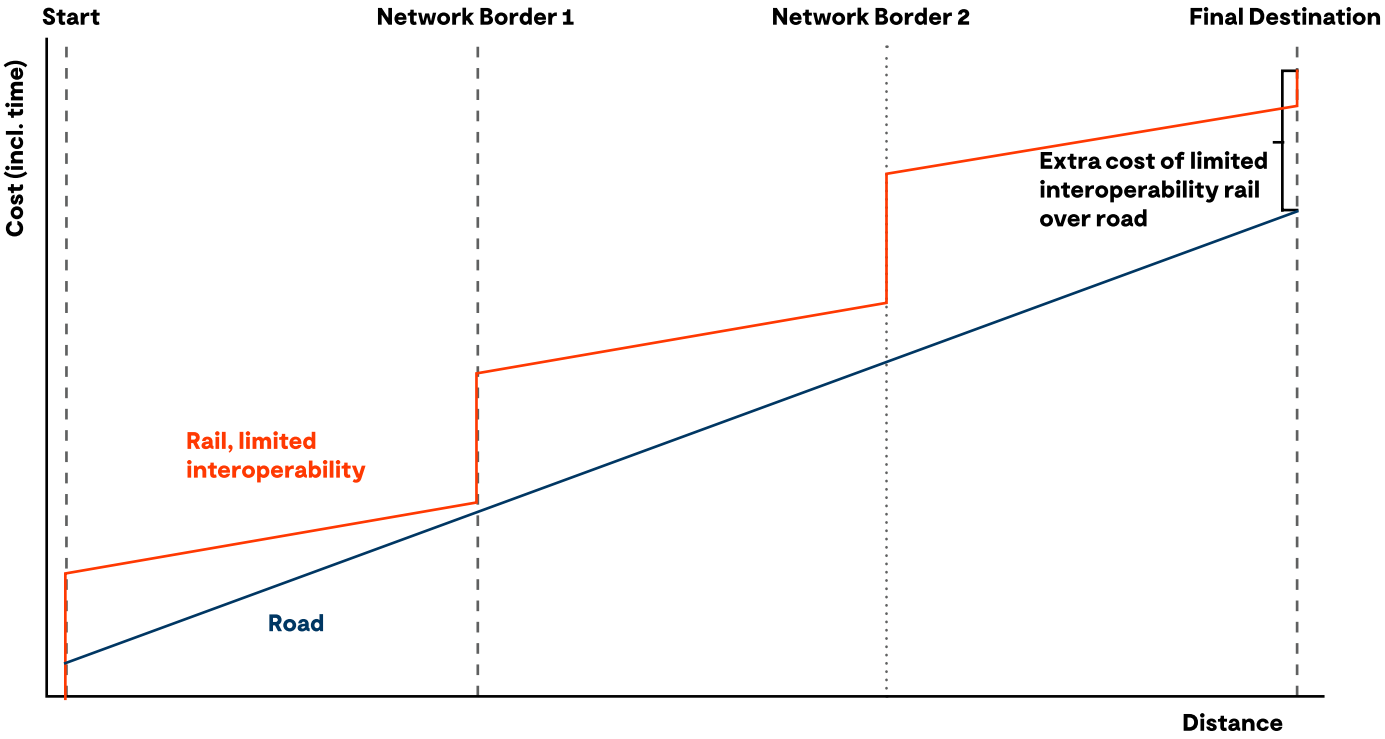
160 Australasian Railway Association (ARA). Interoperability & Regulatory Issues in Australian Rail Freight. ARA, 2021. Pg., 8.

161 European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 7.

162 National Heavy Vehicle Regulator (NHVR). Heavy Vehicle National Law and Regulations. NRVR, N.d., https://www.nhvr.gov.au/law-policies/heavy-vehicle-national-law-and-regulations

mode share for interstate freight, leading to increased emissions and, as a result, impeding national and state-based efforts to decarbonise supply chains and meet decarbonisation goals.

Figure 12 Illustrative impact of a lack of interoperability on rail freight mode competitiveness[163]



Looking forward, standards fragmentation also risks impeding long-term interoperability related to the interfaces and technical specifications for decarbonisation and net zero related rail technologies. Indeed, if an RSO is going to decarbonise, it will likely need to utilise some mix of battery and charging infrastructure, or hydrogen infrastructure (including contingent tank pressures and filling infrastructure), which complies with the standards of the networks on which they operate. However, if different RIMs do not harmonise the relevant standards and instead impose different standards in these new technology areas, it risks a 'break of gauge' between networks, whereby rolling stock configured for the standards one network cannot operate on another network. Not only would this impede rail's value proposition and limit its mode share, but if the required future standards are unclear and potentially differing, this could also lead to delays for RSOs in committing to, and actioning, a decarbonisation strategy in the short term.

Future State Benefit

Increased interoperability because of standards harmonisation would increase the efficiency of rail freight transport across Australia, increasing competitiveness with road and air transport modes. This effect would decrease the absolute and relative cost and transport time of rail, thus increasing rail's value proposition relative to more carbon-intensive modes[164]. A nationally consistent approach to rail standards is also the best to enable relevant stakeholders to efficiently facilitate increased and lower-cost connectivity, including across state borders. It allows for a more efficient flow of goods to their destinations, rather than creating inefficiencies and barriers to industry and the private sector from using rail.[165]

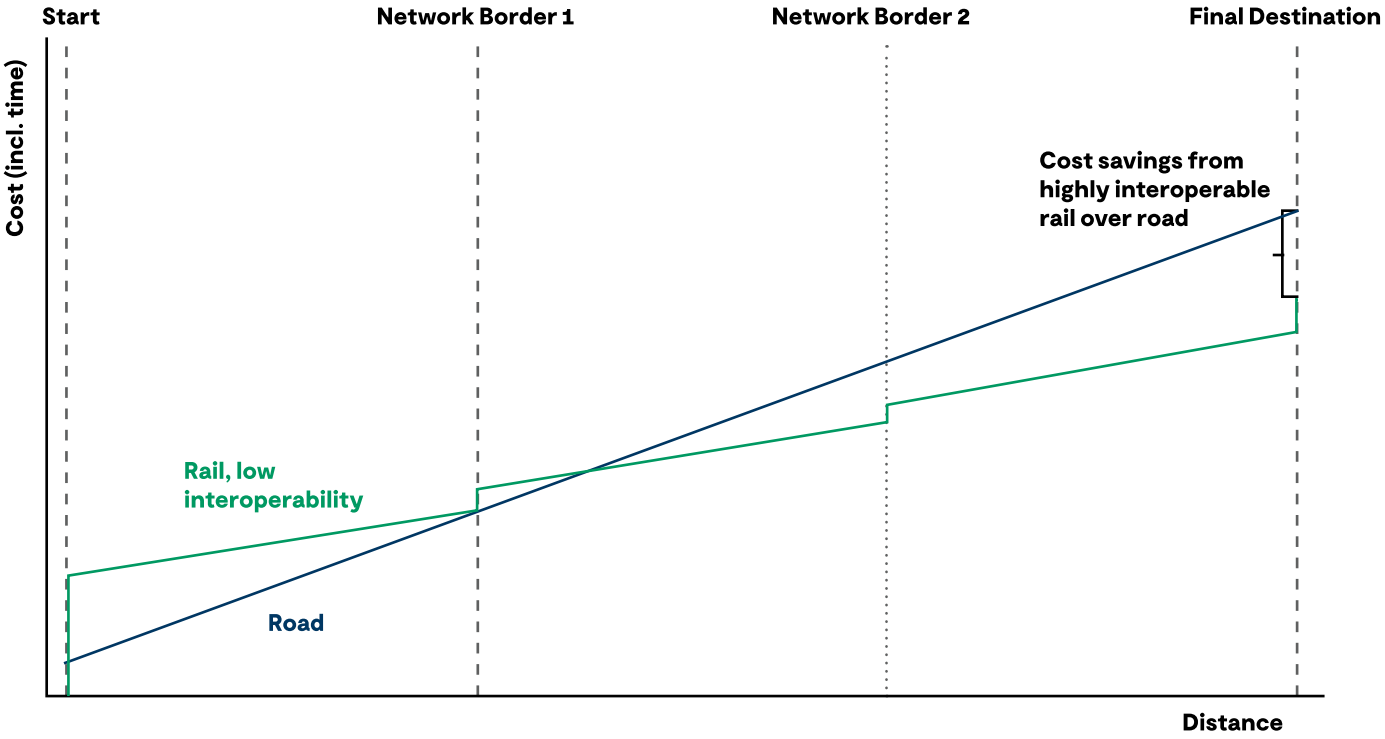
The reduced operating cost of increased interoperability across network borders, relative to road freight, is illustrated in Figure 13 (which is demonstrative only). It is the cost-dynamics illustrated in Figure 13 that would work to increase rail freight mode share.

163 GHD, 2024. Adapted from: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023.

164 SYSTRA. Interoperability: The fast track to a seamless, safer railway system. SYSTRA ANZ, 2023. Pg., 9.

165 KPMG and ARUP, The journey to net-zero: Inspiring climate action in the Australian transport sector. KPMG and ARUP (for Roads Australia, Australian Railway Association, and Infrastructure Sustainability Council), 2022, Pg., 33.

Figure 13 Illustrative impact of increased interoperability on rail freight mode competitiveness[166]



Importantly, as noted above, rail is a far less carbon-intensive mode of transport than the competing modes of road or air. Rail freight, for example, produces 16 times less carbon pollution than road freight per tonne-kilometre travelled[167]. Rail passenger travel also generates 30% less carbon pollution than road travel for each kilometre travelled[168], with Australian metro train systems emitting an average of 3 to 21gCO2/km per person, as opposed to the average car sold in 2015, which emits 184gCO2 /km per person[169]. Ultimately, from a freight-only perspective, a 1% shift of freight moved from road to rail will reduce accident, emission, and health costs nationally by $71.9 million a year[170]. Although, as alternative modes of transport decarbonise, rail may gradually lose this competitive advantage in terms of decarbonisation benefit, it is likely to remain less energy intensive than road freight for the next few decades at a minimum, resulting in less energy demand (irrespective of energy source) from the broader freight sector.

Ultimately, more efficient and reliable service because of increased interoperability will enable a shift away from far more carbon-intensive alternatives, decreasing overall carbon emissions and assisting national and state-based efforts to decarbonise supply chains.[171]

Stakeholder Input:

At the rail equipment suppliers' workshop, attendees noted that the EU has been using energy-efficient technologies that are not available in Australia in their rail network and operations for decades. Attendees noted that if Australian networks cannot adopt these new technologies, they would continue to operate using high carbon emitting technologies, which has the potential to hinder Australia from meeting important decarbonisation and net zero targets. This would have the potential to further impact Australia's position in the global market and attractiveness for international suppliers to engage with the Australian market.

166 GHD, 2024. Adapted from: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023.

167 Deloitte Access Economics (DAE). Value of Rail 2020: The rail industry's contribution to a strong economy and vibrant communities. DAE (for ARA), 2020. Pg., 50.

168 Deloitte Access Economics (DAE). Value of Rail 2020: The rail industry's contribution to a strong economy and vibrant communities. DAE (for ARA), 2020. Pg., 30.

169 Climate Council, cited in: RISSB Horizons 5.0 Reports (Eurostar). Pg., 9.

170 Deloitte Access Economics (DAE). Value of Rail 2020: The rail industry's contribution to a strong economy and vibrant communities. DAE (for ARA), 2020. Pg., 55.

171 SYSTRA. Interoperability: The fast track to a seamless, safer railway system. SYSTRA ANZ, 2023. Pg., 7.

3.2.5 Safety

Current State Problem

The current fragmented nature of networks across Australia has resulted in 17 different safe working systems, among the other differences in standards; with some RIMs having differing and unharmonised safe working and technology requirements even throughout their own single network[172]. This complexity and multiple operating practices mean workers and equipment need to adapt to different practices when moving across (and even within) networks, creating opportunities for dangerous confusion among train operators and other workers, as well as more likely non-compliance or the incorrect application of important safety procedures[173].

As an example, a train driver must remember that a signal which means one thing on one side of a network boundary also means something quite different on the other, posing a risk-creating complexity that would not exist in a harmonised standards environment[174]. A visualisation of select contradictory signal meanings on just Australia's East Coast is provided in Table 7.

Table 7 Select examples of contradictory signal meanings on Australian east coast networks[175]

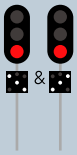
Signal	Queensland	New South Wales	Victoria
Green / Red	*Signal doesn't exist.*	 CAUTION Proceed through this signal, the next signal is at stop.	 CLEAR NORMAL SPEED Proceed at normal speed.
Green / Yellow	*Signal doesn't exist.*	 MEDIUM (PRELIMINARY CAUTION) Proceed, expect the next signal to be at Caution, or a turnout signal.	 PROCEED Proceed, the next signal is at normal speed.
Yellow / Red	*Signal doesn't exist*	 CAUTION TURNOUT Proceed through the turnout, the next signal is at stop.	 NORMAL SPEED WARNING Proceed at normal speed but be ready to stop at the next signal.
Yellow/ Yellow	 Proceed, but be ready to stop at the signal after next.	 MEDIUM TURNOUT Proceed through the turnout, the next signal is at Proceed.	 WARNING Proceed, but be ready to stop at the next signal.
Blinking Yellow	 Proceed at no more than 40 km/h and be ready to stop at the next signal. ← *Signal flashing*	 MEDIUM (PRELIMINARY CAUTION) Proceed, expect the next signal to be at Caution or a turnout signal. ←*Signal flashing*	*Signal doesn't exist*

172 SYSTRA. Interoperability: The fast track to a seamless, safer railway system. SYSTRA ANZ, 2023. Pg., 5

173 Bureau of Infrastructure and Transport Research Economics (BITRE). Optimising harmonisation in the Australian railway industry: report 114. BITRE, 2006. Pg., 44.

174 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 12.

175 GHD, 2024. Compiled from various.

Signal	Queensland	New South Wales	Victoria
Red / White Lights.	 Shunt. Continue to next signal on sight, at no faster than 25 km/h until past next signal. Be prepared to stop at obstruction.	 Train will diverge into area controlled by alternative signalling method. White lights will be angled in direction of diverging route.	*Signal doesn't exist*

Aside from signalling, the multiple different radio systems that RSOs need to use across different networks constitute another risk-creating complexity that would not exist in a harmonised standards environment.

Importantly, as identified in the *Taig Review*, "complexity is the enemy of safety as well as efficiency"[176]. Therefore, the current system whereby an RSO who works across network boundaries must satisfy regulatory requirements in every network, is as unsafe as it is inefficient. It means that safety management systems are larger, more complex, and with a higher possibility of a negative safety event at every level.[177]

Future State Benefit

Harmonising standards between different networks would simplify the operation of rail services across network boundaries and reduce the complexity faced by RSOs. Importantly, this reduction in complexity increases safety by minimising the potential points for failure in the rail system, in turn reducing the likelihood of confusion[178] and costly errors, ensuring safer journeys for freight and passengers[179]. This was also a key conclusion of the Taig Review, which noted that "there would be definite safety benefits of greater harmonisation".[180]

Stakeholder Input:

At the rail equipment suppliers' workshop, attendees noted that reduced safety outcomes can be attributed to the complexity of standards as identified in the initial brainstorming discussion. There are layers of standards even within a single network, and there is more bureaucracy in comparison to international rail networks. Attendees also believed that some standards are over-specified without sufficient economic or technical rationale. Under the current state, there are multiple interfaces and safety approaches between networks, as well as different procedures (i.e. colours of vests differ between networks). This creates hazards particularly where interfaces of different networks meet, which reduces safety outcomes. There are different safety training requirements for different networks, including different safety accreditation courses required to safely access the rail corridor in each state. Accreditation is also not mutually recognised between states, thus a worker completing the training in NSW does not enable them to work in Queensland, or Victoria. Attendees believed that if there was better alignment of safety standards between RIMs, there would be less rules and regulations for workers to remember when working interstate, which would reduce safety risk.

3.2.6 Technology Adoption and Innovation

Current State Problem

The fact that there is limited national harmonisation on the standards for signalling, automation, type approvals, or the other areas of standards that are needed for a modern rail system in the 21st century, means that technology development occurs in silos, with different systems and technologies being developed and adopted across various networks[181]. Indeed, network fragmentation means that bespoke, inefficient solutions are easier to develop than more efficient, collaborative solutions[182]. There is no common starting point for innovation, with Australian RSOs unable to harness the network-scale benefits and efficiencies of technology development, reducing the extent of sector-wide innovation adoption. Importantly, this has been cited as a key reason why public and private funding in Australia for rail research and development (R&D) has historically been significantly lower in Australia than in comparator countries.[183]

176 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 12.

177 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 12.

178 Bureau of Infrastructure and Transport Research Economics (BITRE). Optimising harmonisation in the Australian railway industry: report 114. BITRE, 2006. Pg., 44.

179 SYSTRA. Interoperability: The fast track to a seamless, safer railway system. SYSTRA ANZ, 2023. Pg., 7.

180 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 13.

181 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 3.

182 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 23.

183 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 10-11 (Section 3.1).

A further, related, impediment to the lack of rail technology innovation in Australia, is the lack of clarity of who should bear the costs and who should receive the benefits of any investment. This acts as a root cause disincentivising new product development.[184]

Additionally, the existence of multiple RIMs and RSOs with different standards and related TA processes (see Section 3.2.3), makes Australia a challenging market for existing technology developers and suppliers, including overseas developers and suppliers, who have multiple paths to market for each product they produce[185]. Indeed, that the TA of one RIM does not serve as a 'trust marker' to another, largely because of the different standards between the RIMs, acts as a hurdle to RIMs and RSOs adopting innovative technology, even if it already exists internationally[186]. It can lead to new, more efficient, and more productive technologies either not entering the Australian market or being heavily delayed; and is cited as a key reason why Australia has been much slower than international comparison nations to adopt major rail technologies such as driverless trains and Positive Train Control (PTC)[187]. Instead, the TA process leads to the use of approved, though inferior, technologies and products.

Also importantly, the adverse impact of unharmonised standards applies across the whole rail innovation and technology ecosystem, including for net zero technologies such as hydrogen power and battery storage. Therefore, unharmonised standards may discourage the pursuit and uptake of innovative approaches that could become crucial to Australia's net zero transition, as it has for previous advancements in rail technology, hindering national and state-based decarbonisation efforts beyond their impact on mode share (see Section 3.2.4).

Future State Benefit

Network Scale Adoption

The harmonisation of standards would help to break down the identified silos currently inhibiting the development and implementation of new technologies, including those caused by the nation's disparate TA processes (see Section 3.2.3). This would allow for a more collaborative approach to innovation, enabling RSOs to harness network-scale benefits and efficiencies. As a result, sector-wide innovation adoption could be significantly enhanced, leading to more efficient and effective rail systems across the country, in line with rail sectors overseas.

Encouraging Investment

The adoption of harmonised standards could stimulate increased public and private funding for rail R&D. With a more conducive environment for innovation and technology adoption, investors may be more inclined to support rail R&D initiatives in Australia, including for decarbonisation and net zero technologies. This could lead to a significant increase in the level of investment.

The positive impact of standards harmonisation and higher levels of interoperability on research and innovation has been illustrated in the EU. Indeed, a study by the European Union Agency for Railways on patenting trends showed that since the introduction of mandatory TSIs, European rail companies have filled significantly more patents.[188]

Stakeholder Input:

At the rail equipment suppliers' workshop, attendees agreed that the harmonisation of standards used across Australian rail networks with international standards (i.e., standards used in the EU) would allow for innovations and technology already accepted overseas to be used locally, without being required to undergo lengthy, costly, and complex approvals processes. Type approvals for products can be a multi-year and costly process, even to implement products that have otherwise been proven in the EU to be approved for use on Australian networks. Reducing the gap between standards used in Australia, the EU, and the USA would enable cost-effective and efficient technologies to be implemented in Australia, enabling more efficient and productive operations.

3.2.7 Training Costs and Labour Mobility

Current State Problem

The different standards system-based safe working rules imposed by different RIMs and RSOs mean that there are different skills and training requirements for workers across networks. This creates significant inefficiencies by increasing training costs for RSOs, as well as reducing labour mobility between Australian networks.

184 See Stakeholder Engagement Report (Appendix A).

185 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 20.

186 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 23.

187 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 14-15 (Section 3.4).

188 European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 7.

Firstly, the different skills and training requirements increase training costs, reducing training and development opportunities. This is because the lack of standards harmonisation for safe interoperability requires RSOs to have suitably accredited staff for every single network they operate, imposing additional costs in management, maintenance, and competency training[189]. It means that staff need to be trained for more than one network, introducing duplication and inefficiency relative to a harmonised and interoperable standards environment. An example of this process is the different communications and signalling system standards and requirements across different networks (see Section 3.2.1), which means that in-cab staff need to be trained in multiple systems that serve the same purpose.

Secondly, the range of standards developed by the different RIMs negatively impacts the ability to enter, exit, or transfer across the industry ("labour mobility"), with many skills not easily transferrable between networks[190]. Trained rail professionals on one network are often not able to work on another network without costly retraining, as the other network has different training requirements because of their different standards regimes, which creates a barrier to the mobility of staff across the nation[191]. As an example, different networks have various Safely Access the Rail Corridor (SARC) courses and different expiry dates. Some of these have different course content and some of which, such as TLIF0020 on the QR network, are not accepted without a bridging course. This means that a rail professional trained on the V/Line network (for example) cannot easily move to the QR network without undergoing costly retraining even if they already know most of the course content, lowering labour mobility and creating inefficient and duplicated costs and effort.

The ability for labour to easily move to the location it is required to engage in the market is key to connecting employees and employers[192]. Without this mobility, existing regional mismatches of skills and locations are intensified, and labour shortages increase[193]. This is especially important for the rail sector, given that the 165,000-strong Australian rail workforce is estimated to have a 70,000-worker shortfall given a looming 'retirement cliff'[194]. This retirement cliff is most likely to impact several technical and operational roles (see Figure 14), for which different standards are most restrictive of labour mobility.

Figure 14 Technical and operational roles with an average age higher than the industry mean[195]

Roles	
– Train Driver. – Maintenance Technician (esp. signalling). – Operations Manager.	– Rail Tester (esp. signalling). – IT & Technology Assistant. – Learning & Development Manager

Additionally, the current training challenges linked to a lack of harmonised standards impact a significant number of workers. For example, interstate freight operator Qube has 10,000 employees and operate across 200 locations throughout Australia (including non-rail personnel)[196], while competitor Pacific National has a team of more than 3,400 people working across 70 sites around Australia.[197]

Importantly, the lack of labour mobility imposed by differing standards nationwide also works to drive up the costs of developing infrastructure projects, where specialists might be needed to apply their trade at sites across different networks.

Future State Benefit

Harmonising disparate standards regimes would reduce the training costs for RIMs and RSOs across Australia's rail sector[198]. This is centrally only because it would reduce the skills training burden for employees moving between RIMs and RSOs, who may need to be retrained to understand and comply with a different set of standards.

189 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 13.

190 Australasian Railway Association (ARA). Building Australian Rail Skills for the Future. ARA, 2022. Pg., 26.

191 National Transport Commission (NTC). National Rail Action Plan. NTC. Pg., 14.

192 Australian Chamber of Commerce and Industry (ACCI). Overcoming Australia's Labour & Skills Shortages: Through Skills Development, Workforce Participation and Migration. ACCI, 2022. Pg., 9

193 Australasian Railway Association (ARA). Building Australian Rail Skills for the Future. ARA, 2022. Pg., 26.

194 Australasian Railway Association (ARA). Australian rail workforce on the edge of a retirement cliff. ARA Media Release, 2023. https://ara.net.au/media-release/australian-rail-workforce-on-the-edge-of-a-retirement-cliff/.

195 Adapted and presented by GHD from: Australasian Railway Association (ARA). The Rail Workforce: An Analytical Overview. ARA, 2023. Pg., 16.

196 Qube. Working at Qube. https://qube.com.au/careers/working-at-qube/

197 Pacific National. Working at Pacific National. https://pacificnational.com.au/our-people/

198 AECOM. RISSB Cost-Benefit Analysis. AECOM (for RISSB), 2012. Pg., 6.

Additionally, a harmonised standards system would facilitate labour mobility[199]. If all RIMs were to adopt a harmonised set of standards, employees would be able to move freely between different RIMs without the need for additional or duplicated training. This increased labour mobility could lead to a more efficient allocation of resources, as employees could be deployed where they are most needed, regardless of the specific RIM. Furthermore, it could also work to mitigate existing skills shortages in the sector.

In addition to the industry benefits of harmonised standards, employees would benefit from nationally recognised qualifications and experience. This would improve employability, career and relocation opportunities, and skills development.

199 SYSTRA. Interoperability: The fast track to a seamless, safer railway system. SYSTRA ANZ, 2023. Pg., 13.

4. Opportunities, Barriers, and Risks

4.1 Opportunity for Harmonisation

There are several factors currently at play, that together constitute a real opportunity for rail standards harmonisation in the short term. These include the following, which are each discussed in the subsections below:

Favourable Policy and Strategic Environment

Key Stakeholder Agreement and Alignment

Significant Short-Term Infrastructure Investment Pipeline

Imminent Technological Advances

Importantly, each of these opportunities for rail standards harmonisation is prone to change or inherently ephemeral. Each could or will pass, meaning that if meaningful action is not taken on rail standards harmonisation in the short term, then the window of opportunity for action could be lost.

4.1.1 Favourable Policy and Strategic Environment

A favourable policy and political environment provide an opportunity for lasting change in any given area because it creates an atmosphere that is conducive to the introduction, acceptance, and implementation of change among key decision makers and other stakeholders. This also generates momentum and support for other interoperability and harmonisation reforms. Importantly, such a favourable policy environment now exists for rail standards harmonisation.

The favourable policy environment is best reflected in the fact that "aligning train control and signalling technology on the eastern seaboard" is a formal ministerial priority of National Cabinet[200]. Additionally, rail interoperability is one of eight federation reforms which the National Cabinet has chosen to focus on[201]. This commitment has been built off of other, recent, standards harmonisation and interoperability-related agreements, such as the Australian Transport and Infrastructure Council's 2016 unanimous agreement to prioritise the harmonisation of standards for the manufacture of bogies in trains, as well as windows and other glazing componentry. [202]

200 National Transport Commission (NTC). National Rail Reform: Post ITMM Briefing. Presentation Slides, July 2023. NOTE: National Cabinet has delegated Infrastructure and Transport Ministers (through ITMM) to progress the issue of improving the interoperability of rail systems. In December 2022, the Minsters of ITMM agreed that the National Transport Commission (NTC) focus on five priority areas identified as critical pain points for the rail industry, including "aligning train control and signalling technology on the eastern seaboard".

201 Burton, Tom. National cabinet seeks to end scourge of multiple rail systems. Australian Financial Review, 2023. https://www.afr.com/politics/federal/national-cabinet-seeks-to-end-scourge-of-multiple-rail-systems-20230116-p5ccpo.

202 Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

Furthermore, several government policy planning and strategy documents have been produced that reflect the current, supportive, policy environment that is providing the opportunity for lasting standards harmonisation. These include the *National Rail Action Plan* and the *National Rail Manufacturing Plan and Strategy*, which are outlined below.

National Rail Action Plan (2020)

The *National Rail Action Plan (NRAP)*[203] is an agreed set of actions that will be undertaken by the Commonwealth, state and territory governments and key members of the rail industry. It aims to implement changes to improve the delivery of rail infrastructure and improve the safety and productivity of rail operations, as well as create opportunities for manufacturers of rail equipment to supply rolling stock and components. The actions under the NRAP have two main focuses, as follows:

1. To ensure we have the skills and labour required to build and operate the rail network.
2. To improve the efficiency and safety of Australia's rail system by continuing to align or harmonise operating rules, infrastructure and operational standards and systems across the nation's rail network.

From an opportunity perspective, the *NRAP* is one of the most significant rail planning documents of this generation and explicitly notes national infrastructure and operational standards harmonisation as a key strategic action. As such, there is clear policy direction and imperative for some degree of national standards harmonisation and change.

Additionally, the *NRAP* contains actions specifically around the following four areas, all of which are significantly related to standards harmonisation:

- "Common rules for infrastructure standards.
- Common standards for components for rolling stock.
- Common rules for safe work.
- Interoperable communication and control systems".[204]

Priority areas of action under the NRAP areas include the following: "codifying a small number of critical national standards and rules", "reduce interoperability burden from a worker perspective", and "streamline rolling stock approvals and other red tape". Ministers have also agreed to "identify and codify a small number of critical mandated standards" for (1) Digital Train Control Technology, (2) Single On-board Interface for drivers and crew, and (3) Streamlining rolling stock approvals, under a four-year fully funded NRAP Phase 2 program[205]. Importantly, areas and actions are all highly aligned with the harmonisation of rail standards, further demonstrating the opportunity provided by the supportive policy environment.

National Rail Manufacturing Plan (2023)

The *National Rail Manufacturing Plan (NRMP)*, established under the Office of National Rail Industry Coordination (ONRIC) within the Commonwealth Department of Industry, Science and Resources (DISR), outlines the Government's vision of "driving a globally competitive rail manufacturing sector to lift productivity, improve social and environmental outcomes and deliver economic value".[206]

Under this wider vision, the *NRMP* defines the following four objectives of:

- A nationally coordinated approach to government procurement and investment.
- A more efficient domestic supply chain selling to local and export markets.
- Global leaders in research, design, innovation, and adoption.
- Rewarding careers and a highly skilled, diverse workforce.[207]

Importantly, harmonised rolling stock standards are a clear key enabler in achieving the first two objectives. Therefore, this *NRMP* provides a clear opportunity and impetus for standards harmonisation through an appropriate national rail standards harmonisation option.

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203 Anderson, David Edwards. "Update on Harmonisation of Rolling Stock Standards and What's Next." Paper presented at the AusRAIL, Canberra, 27-28 November 2018. https://trid.trb.org/view/1631727.

204 National Transport Commission (NTC). National Rail Action Plan. NTC. Pg., 2.

205 National Transport Commission (NTC). National Rail Action Plan: Rail Industry Executive Committee. Presentation Slides, 23 August 2023.

206 Office of National Rail Industry Coordination (ONRIC). National Rail Procurement and Manufacturing Plan.

207 Office of National Rail Industry Coordination (ONRIC). National Rail Procurement and Manufacturing Plan.

National Rail Procurement and Manufacturing Strategy (2023)

The *National Rail Procurement and Manufacturing Strategy* is a key part of Phase 1 of ONRIC's *NRMP* profiled above. The *Strategy* outlines how the Australian government will work with states and territories, industry, unions, and other key stakeholders to help deliver a more collaborative approach to passenger rolling stock procurement and grow a competitive rail manufacturing sector.[208]

The strategy sets out actions, grouped under 6 pillars. These are as follows:

- Pillar 1: Develop a nationally coordinated approach to rolling stock procurement.
- Pillar 2: Harmonise standards for manufacturing rolling stock.
- Pillar 3: Adopt a national local content approach.
- Pillar 4: Maximise opportunities for freight and heavy haul rail manufacturing.
- Pillar 5: Improve research and innovation outcomes in the rail sector.
- Pillar 6: Establish the foundation for good jobs and rewarding careers in rail manufacturing.[209]

Of these pillars, Pillar 2 (Harmonise standards for manufacturing rolling stock) relates directly to standards harmonisation in Australia. In the discussion of Pillar 2, the *Strategy* notes not only that "harmonising standards for rolling stock will improve economies of scale, increase production runs and lower unit costs for Australian manufacturers", but also that "this will support a more competitive and efficient domestic rail manufacturing sector"[210]. This work is also intended to complement the current rail harmonisation work led by the NTC and RISSB.[211]

The synergy between Pillar 2 of the *Strategy* and an appropriate standards harmonisation option provides a clear opportunity and impetus for meaningful and lasting action.

Rail Safety National Law Review (2024)

In June 2024, the NTC published a review of the *RSNL*. The review considers whether the functions of the *RSNL* adequately reflect the regulatory requirements of the rail sector, 11 years after it was implemented. The review had reference to administering the *RSNL*, as well as transparency, interaction with Work Health and Safety legislation, co-regulation, roles and responsibilities, and flexibility.[212]

Importantly in the context of rail standards harmonisation, the review made the several key conclusions and recommendations that clearly align with the broad goals of harmonisation and greater interoperability. Chief among these was that the *RSNL* "be amended to include additional provisions to embed interoperability outcomes in the *RSNL*, and to compel decision makers and duty holders to consider impacts on adjacent networks and the national network more broadly to achieve required interoperability outcomes"[213]. Specific recommendations related to harmonisation and interoperability in the review are outlined in Table 8.

Table 8 Rail Safety National Law Review select recommendations – harmonisation and interoperability[214]

Recommendation #	Recommendation (whole or part)
1	"The RSNL should be amended to strengthen the link between safety and productivity … This could particularly be the case for the defined National Network on Interoperability (NNI) to achieve mandated interoperability outcomes."
3	"Provisions be established in the RSNL to enable the mandating of requirements to achieve specified interoperability outcomes that will deliver safety and productivity benefits across the national rail network, and for the rail industry more broadly …"
16	"Interoperability should be listed as a new object in the RSNL to build on the already ministerially approved requirement for an interoperability management plan to be included as an additional element of the safety management systems (SMS)".

208 Office of National Rail Industry Coordination (ONRIC). National Rail Procurement and Manufacturing Strategy. DISR, 2023. Pg., 6.
209 Office of National Rail Industry Coordination (ONRIC). National Rail Procurement and Manufacturing Strategy. DISR, 2023. Pg., 6.
210 Office of National Rail Industry Coordination (ONRIC). National Rail Procurement and Manufacturing Strategy. DISR, 2023. Pg., 16.
211 Office of National Rail Industry Coordination (ONRIC). National Rail Procurement and Manufacturing Strategy. DISR, 2023. Pg., 16.
212 National Transport Commission (NTC). Rail Safety National Law Review: Final report. NTC, 2024. Pg., 2.
213 National Transport Commission (NTC). Rail Safety National Law Review: Final report. NTC, 2024. Pg., 8.
214 National Transport Commission (NTC). Rail Safety National Law Review: Final report. NTC, 2024. Pg., 6-10.

Recommendation #	Recommendation (whole or part)
17	"For the NTC, ONRSR, and the Rail Industry Safety and Standards Board (RISSB) to lead the development of an interoperability guideline or approved code of practice …"
18	"For any changes to network rules or infrastructure, the RSNL should compel RIMs to: a) Consider implications to their own and adjacent networks. b) Require consultation with all interfacing rail transport operators and other affected parties, and provide fair consideration of their reasonable operational requirements; and c) Have regard to potential impacts to the wider national network and consider the overall network as a national 'system'."
19	"There should be a presumption of mutual recognition whereby testing and assessments for technology approved by one operator can be relied upon by an adjacent operator …"
20	"Establish a national set of competencies that would be recognised by all RTOs …"

The review's focus on embedding productivity, efficiency, harmonisation, and interoperability within the RSNL has not been present since the RSNL was first implemented. This points to a new, favourable, policy and strategic environment in favour of rail standards harmonisation, which represents an opportunity to advance rail standards harmonisation in a way that has been absent for much Australia's rail history.

4.1.2 Key Stakeholder Agreement and Alignment

Ensuring key stakeholder alignment is important to regulatory or institutional change of any form. This is because key stakeholder alignment ensures minimal blockages and disruptions to a change, instead fostering a shared ownership and cooperative environment under which advancements and operational transformation can occur.

Importantly, there is key stakeholder alignment acknowledging the issues posed by a lack of harmonised standards in key areas such as interoperability and manufacturing. RISSB member research conducted in 2022 concluded that the harmonisation of standards and networks is the top priority for industry[215]. Along with labour shortages, standards and networks harmonisation was identified as one of two 'Tier 1' challenges/opportunities by the industry. "Interoperability of networks", which is partially a function of standards harmonisation, also ranked as a 'Tier 2' priority, as did "productivity of the sector", which is a function of interoperability.[216]

Memorandum of Cooperation (2023)

As a further illustration of the key stakeholder alignment that provides an opportunity for meaningful action on rail standards harmonisation, in March 2023, Australian governments and industry signed the "Memorandum of Cooperation (MoC) to support National Rail System Interoperability for future major rail investments". This MoC, which was signed by all State and Federal Governments, as well as a range of transport manufacturers, RIMs, and RSOs included a commitment to take a more national focus when making decisions on future rail investments.

The MoC signatories acknowledged "that different rules, standards, systems, gauges and rolling stock stymie rail's capacity to operate as a seamless national network to lift Australia's productivity". Although non-binding and without any financial, legal, or other type of obligation, the MoC does note that "there is a need for more formal coordination and adoption of a national view and implementation of measures that will drive greater interoperability to advance safety and productivity across rail networks for the collective good".[217]

In response to the signing of the MoC, the Minister for Infrastructure, Transport, Regional Development and Local Government, Catherine King, also stated that "improving interoperability of the national rail network will mean more people will be employed, more manufacturing will be local, and more passenger and freight services will travel by rail".[218]

215 Phillips Group. Summary of preliminary findings: RISSB Member Research. Phillips Group (for RISSB), 2022.

216 Phillips Group. Summary of preliminary findings: RISSB Member Research. Phillips Group (for RISSB), 2022.

217 National Transport Commission (NTC). Memorandum of Cooperation to support National Rail System Interoperability for future major rail investments. NTC, 2023.

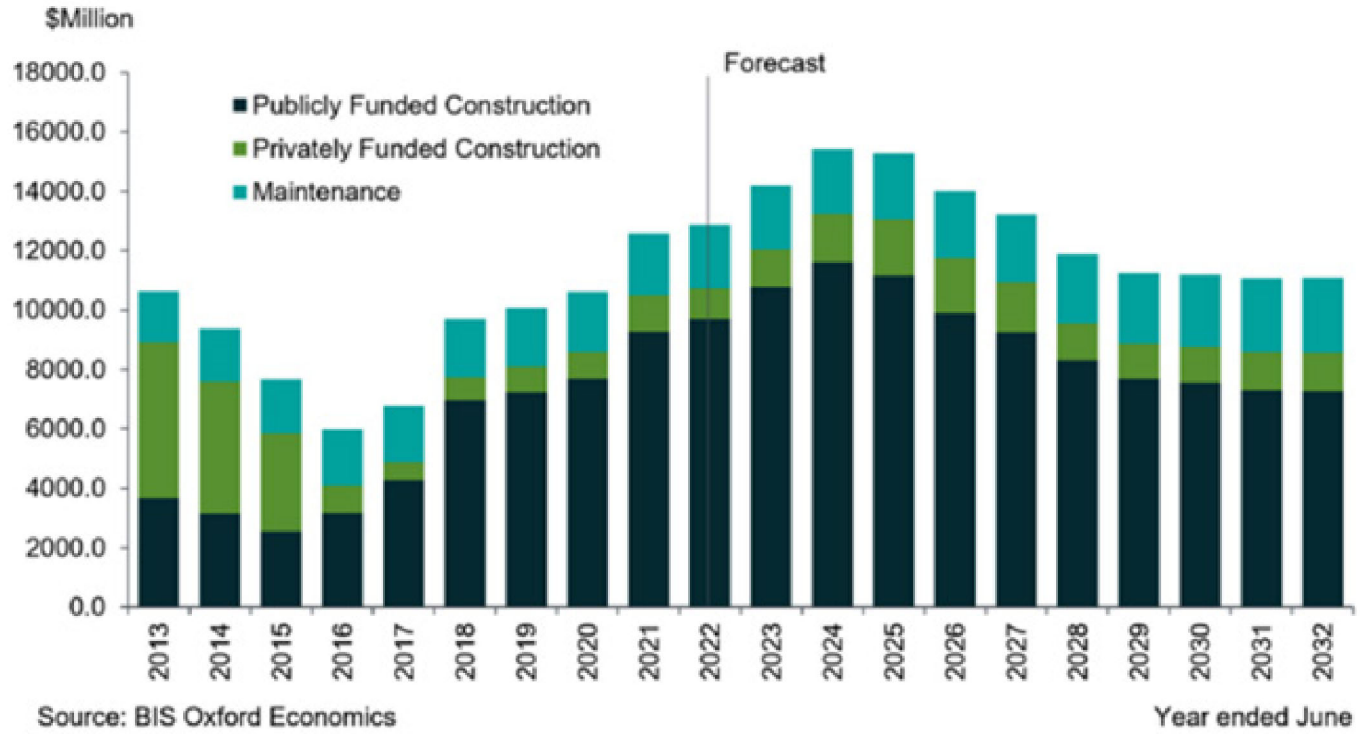
218 Catherine King. Once-in-a-generation opportunity to get Australian rail back on track. Commonwealth Government Media Release, 2023. https://minister.infrastructure.gov.au/c-king/media-release/once-generation-opportunity-get-australian-rail-back-track.

Importantly in the context of the opportunity for meaningful rail standards harmonisation, this level of formal agreement on the problems and causes of limited rail interoperability, both in this MoC as well as in the policy outlined in Section 4.1.1, has not been seen previously in Australian rail history. Instead, agreement and understanding of any form have been elusive and uncommon in past rail standards harmonisation debates.

4.1.3 Significant Short-Term Infrastructure Investment Pipeline

Over $155 billion is forecast to be invested in rail over the next 15 years, which represents a previously unseen level of infrastructure investment in the industry[219]. Additionally, as a swathe of large, publicly funded rail projects continue to ramp up across Australia, $14.4 billion is expected to be invested annually over the next five years[220]. In the decade from 2021-22 to 2031-32, $105 billion in rail civil construction is forecast, compared to $77 billion over the preceding decade and representing an approximately 36% increase[221]. The historical and future railway investment pipeline to 2032 is illustrated in Figure 15.

Figure 15 Australia railway construction and maintenance pipeline[222]



The substantial investment pipeline presents a unique opportunity to bolster Australia's rail manufacturing sector, catering to the historically unprecedented local demand shown in Figure 15, and increasing export potential. It paves the way for a more nationalised market for rolling stock and other rail components, fostering the economies of scale advantages essential for enhanced domestic production, as well as creating a more unified, cohesive, and collaborative national rail future. Conversely, without coordinated action on standards harmonisation, this significant opportunity to embed interoperability and integration within national rail networks will be lost.

Given the magnitude of expenditure on rail projects and operations, even modest efficiency improvements resulting from the appropriate application of harmonised national standards have the potential to generate significant investment returns for operational interoperability and rail equipment supply.[223]

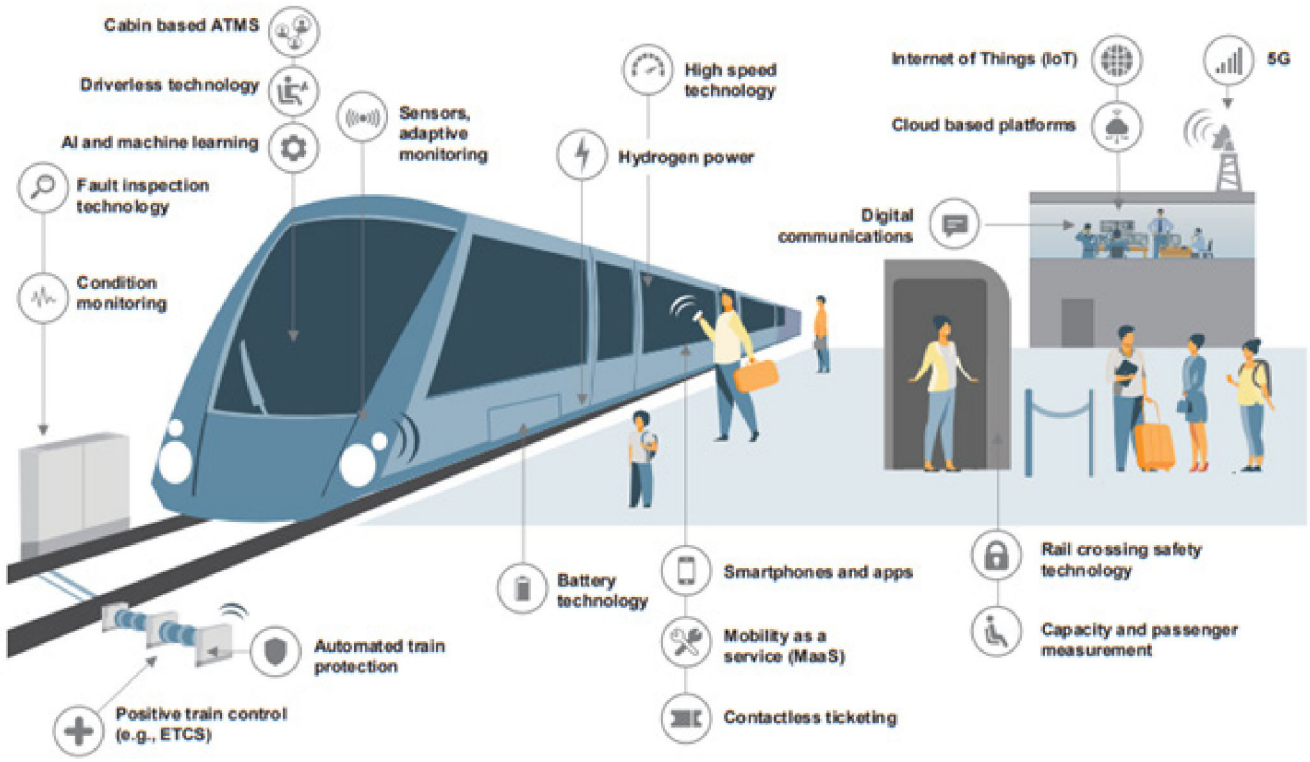
Alternatively, given this significant investment pipeline outlined above, the continued progression of projects in a non-harmonised environment can increase the costs of future harmonisation, as more extensive and complex networks and systems will need to be aligned.

219 Australasian Railway Association (ARA). ARA Submission 2022 - 23 Commonwealth Budget. 2022. The Treasury. Pg., 11.
220 Australasian Railway Association (ARA) and BIS Oxford Economics, Australian Rail Market Outlook. ARA, 2022. Pg., 5.
221 Australasian Railway Association (ARA) and BIS Oxford Economics, Australian Rail Market Outlook. ARA, 2022. Pg., 9.
222 Australasian Railway Association (ARA) and BIS Oxford Economics, Australian Rail Market Outlook. ARA, 2022. Pg., 7 (Figure 2.1).
223 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 30.

4.1.4 Imminent Technological Advances

With recent and rapid technical advances in several new frontiers such as Hydrogen (H2) trains, fuel cells, and battery-energy storage systems[224], the rail industry is on the cusp of a potential step change in how the industry operates. This step change could be comparable in magnitude to the electrification of various previously diesel-powered networks, or the first introduction of automatic train protection (ATP). An overview of the significant technological changes that could be made across the rail network in the coming years and decades, is provided in Figure 16.

Figure 16 Examples of new technology, innovation, and digitalisation in rail [225]



Importantly, the new technologies associated with the rail network of the future will require the development of new and appropriate standards that will govern their operation and adoption by RIMs and RSOs. And, importantly, if RIMs adopt different new technologies using different standards, there is the risk that these new systems, such as modern train control systems, will not be interoperable with each other across different networks. This fact, coupled with the high implementation costs and long economic life of many of the rail technologies associated with the coming step change, risks an extended 'lock-in' of non-interoperability.

Ultimately, the coming step change in the rail sector provides an opportunity and impetus to act on investment in consistent and complementary technologies delivering standards harmonisation. A harmonised standards environment would enable Australia to achieve the maximum 'whole-of-nation' scale congestion reduction, decarbonisation, productivity, and other benefits from adopting future rail technologies, whatever they may be.[226]

Conversely, if harmonisation is only attempted after different RIMs and RSOs have adopted different new technologies using non-interoperable signalling, automation, smart rail, or other standards, or not achieved at all, then the value proposition of standards harmonisation is diminished. Instead, the current interoperability issues and associated problems and missed benefits will be perpetuated into the future. This will represent a significant missed opportunity.

224 US Department of Transportation Federal Railroad Administration. USA Perspective on Standards, Interoperability and Harmonization. Presentation Slides, 17 November 2023.

225 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 4 (Figure 2).

226 Australasian Railway Association (ARA) and L.E.K., Finding the fast track for innovation in the Australasian rail industry. ARA, 2020. Pg., 3.

4.2 Barriers to Harmonisation

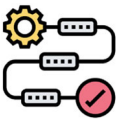
Unlike in the EU and America, standards harmonisation in Australia is voluntary. This means that it is fully up to the stakeholders in the railway industry to commit to interoperability improvements and develop harmonisation between networks.[227]

Importantly, in Australia's voluntary rail standards regulatory environment, there are explanations for why the development of national standards has not led to a more harmonised rail industry. These barriers, which can be based in RIMs and RSOs largely technical or risk averse rationales for the use of bespoke, local standards, can also be attributed to various factors, including regulatory, historical, financial, political, geographical, technical, governance, and operational challenges. These barriers are often combinations of multiple, interrelated, challenges, which create complex environments and disincentives to change.

The key barriers to harmonisation as identified through extensive stakeholder engagement as documented in the Stakeholder Engagement Report (Appendix A), as well as in the literature, can be condensed into the following key themes:

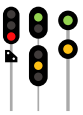
Minimal Incentive to Change

Lack of Information Sharing and Collaboration



Path Dependency

Nature of Voluntary National (RISSB) Standards



Network Operating Differences

Compliance Costs and Commercial Pressure.

Risk Averse Culture

Each of these identified barriers to harmonisation is discussed in the subsections below.

4.2.1 Minimal Incentive to Change

Collective action problem:

"Any situation in which the uncoordinated actions of each player may not result in the best outcome he or she can achieve". [231]

In Australia, RIMs consider whether they should implement or change the operational systems and infrastructure that govern their operation, considering only their internal cost and benefit of such a change[228]. Indeed, each RIM only has the incentive to make network-level decisions that provide the best-perceived outcome for themselves and the customers and community within their jurisdiction, which often means that there is limited consideration of the impacts of those decisions beyond the network[229]. Despite notional duties of cooperation under the RSNL, there is currently no requirement and only limited imperative or incentive for a RIM to consider other RIMs or RSOs outside their network, even though RSOs travel over multiple different boundaries and networks[230]. There is also no governance framework or structure of leadership and accountability incentivising or enforcing standards harmonisation, nor are there any formal, enforced, direction to pursue change.

Importantly, this commercial environment has created an incentive structure in the Australian rail sector that represents a classic example of a "collective action problem", where individual entities' discrete behaviours create barriers to achieving a collectively beneficial outcome.

227 Rail Industry Safety and Standards Board (RISSB). Rail Systems Interoperability Guidelines. 2015. Pg., 7.

228 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 3.

229 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 14.

230 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Overview. Palazzi Rail (for RISSB), 2022. Pg., 2.

231 Oxford Reference. Collective-action problem. https://www.oxfordreference.com/display/10.1093/oi/authority.20110803095623963.

Collective Action Problems and Independent Decision-Making by RIMs

Collective action problems arise when individuals or entities, acting independently and in their own interest, fail to achieve outcomes that are optimal for the group of entities. This classic dilemma is central to the barriers faced by Australia's RIMs under the incentive structure that they face. Indeed, each RIM, driven by the need to optimise the safety, performance, and cost-efficiency of their specific network, operates autonomously, making decisions that provide the best outcome for their customers, community, and network[233]. As a result, decision-making processes have limited consideration of the impacts of those decisions beyond their network[234], with limited regard for the national picture. This network-level optimisation often leads to decisions that benefit one network, while potentially creating larger inefficiencies for others. Each RIM's rational, discrete behaviour leads to a fragmented rail system, where the pursuit of individual network optimisation results in a suboptimal outcome for the national rail infrastructure. This dynamic is even further complicated by the fact that most RIMs are State government entities, yet governments are also wearing some of the cost of lack of interoperability, such as through less domestic manufacturing, increased emissions, and decreased national productivity.

Network Control Systems: A Case Study in Collective Action

If implemented without coordination, the transition to new network control systems by individual RIMs will lead to compromised national outcomes. While each RIM may achieve some local benefit, the lack of a unified approach results in missed opportunities for efficiency gains, unrealised safety improvements, and increased costs across the rail industry. This reduces overall productivity and hampers the rail sector's contribution to the national transport system. [232]

Ultimately, in a voluntary standards regulation environment, the misalignment of incentives means that the short-term decision incentive for each RIM is to focus on local optimisation and cost savings, even if it leads to a collectively suboptimal outcome. Optimising every single network does not mean optimising the entire network, with the overall solution sub-optimal from a national perspective[235], particularly for RSOs moving between networks.[236]

The challenge of the collective action problem in rail standards harmonisation lies in the fact that, while harmonisation would provide collective benefits, such as improved interoperability and efficiency, RIMs have muted commercial incentives to bear the costs and risks associated with these changes[238]. Each RIM's performance metrics are often tied to network-specific safety and efficiency, which discourages investment in harmonisation efforts that have broader, long-term benefits, which may not accrue to the individual RIM. For example, a RIM might opt to maintain older, non-interoperable, technology that meets their immediate needs rather than investing in a standardised system that would benefit the national rail system with minimal benefits accruing at the national level. This dynamic impacts RIMs commercial business cases and the cost and benefits of adopting collectively beneficial interoperable systems technology.[239]

Incentive Interdependency: The Impact of Local Content

Research by ONRIC on local content requirements and procurement processes has identified an interdependency with harmonised standards, whereby disparate local content approaches reduce the incentive for harmonised standards between jurisdictions. This could be because the jurisdictions are incentivised to work independently when local content approaches are different. [237]

Additionally, the interplay between the incentive barriers creates a self-reinforcing cycle that exacerbates the collective action problem within Australia's rail system. Indeed, the fragmentation driving the collective action problem is self-reinforcing, because the more each RIM focuses on its local needs, the less incentive there is for other RIMs to invest in compatible technologies, leading to further and ongoing divergence.

232 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Explanatory paper. Palazzi Rail (for RISSB), 2022. Pg., 11.

233 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 14.

234 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Overview. Palazzi Rail (for RISSB), 2022. Pg., 2.

235 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Overview. Palazzi Rail (for RISSB), 2022. Pg., 3.

236 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 14.

237 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 43.

238 Bureau of Infrastructure and Transport Research Economics (BITRE). Optimising harmonisation in the Australian railway industry: report 114. BITRE, 2006. Pg., 82.

239 National Transport Commission (NTC). National Rail Action Plan. NTC. Pg., 15.

Harmonisation as a 'Prisoners Dilemma'

A paradox seen predominantly in game theory, in which two (or more) entities acting for their own rational interest do not produce the optimal outcome.

Prisoner's Dilemma:
A paradox seen predominantly in game theory, in which two (or more) entities acting for their own rational interest do not produce the optimal outcome. [240]

In the context of a collective action problem, standards harmonisation can be likened to a 'prisoner's dilemma' where each RIM faces a voluntary choice between two options: to harmonise standards or to continue with bespoke, disparate, standards. The dilemma arises because the decision to harmonise requires upfront investment and a leap of faith in the cooperation of other RIMs. Without a guarantee that others will also commit to harmonisation, each RIM risks incurring costs without the return on investment that a harmonised network would provide. This uncertainty can lead to a stalemate where no RIM wants to make the first move. The result is a network where inefficiencies persist, and the potential benefits of a harmonised system remain unrealised, demonstrating the challenge of achieving collective action when individual incentives are not aligned.

Stakeholder Input:

At the ILM workshop, attendees identified the key root cause for standards inconsistency as the general lack of a unified national vision and leadership for operational systems and infrastructure, as well as a lack of incentives for RIMs to implement a national approach to standards. Attendees also agreed that what might be individually beneficial for RIMs is not necessarily beneficial to the nation or conducive to achieving interoperability.[241]

Furthermore, at the RIMs workshop, attendees agreed that there was a general lack of incentive for RIMs to develop and adopt a harmonised set of standards. Attendees noted that there is also a perceived risk for RIMs, particularly regarding standards for safety and reliability, while there is no incentive for them to bear this risk. Attendees also noted that RIMs would prefer to be involved in the development of a harmonised set of standards, if such a set were developed. The alternative of adopting standards developed without their input was perceived as a significant risk (see Section 4.2.6).

Additionally, at the RSOs workshop, attendees similarly believed that a key barrier was the lack of incentives for RIMs to adopt harmonised standards, including the high costs associated with harmonisation (see Section 4.2.6). Attendees believed that under the current state, RSOs carry most of the cost and risk, and there was little incentive for RIMs to carry this cost of change instead. It was noted that RIMs operate in response to their organisations' objectives, which are generally to maximise performance and minimise safety risk within their networks, and which may not necessarily align with the objectives of RSOs or be conducive to achieving interoperability.

RSO workshop attendees also noted that they perceived ONRSR had no incentive for harmonising, as it would disrupt the status quo by implementing substantial changes to the current co-regulated environment under which they operate. Some attendees also noted that some RISSB standards may not even be considered compliant under the ONRSR, and in many cases, the outcomes of ONRSR audits and recommendations can even incentivise RIMs towards developing bespoke standards.

4.2.2 Lack of Information Sharing and Collaboration

Aside from the fact that standards differ between networks, the specific differences in these standards are not readily accessible to RIMs or RSOs. Instead, much of the information remains 'commercial-in-confidence'[244], meaning that RIMs and RSOs are without a readily available way of understanding the standards used in even a neighbouring network, making alignment and harmonisation difficult[245]. This lack of access to standards information presents a significant challenge in information sharing, which not only increases compliance costs (though transaction/

240 NOTE: In the classic example, two accomplices in a crime are arrested and interrogated separately. They are unable to communicate with each other and are faced with the choice to stay silent or betray the other, in exchange for a lighter sentence provided that the other prisoner does not also choose to betray. The dilemma arises because each prisoner has an incentive to betray the other, hoping to receive a lighter sentence. However, if both prisoners choose to betray, they end up with a worse outcome than if they had both cooperated.

241 NOTE: See the Stakeholder Engagement Report (Appendix A) for further information on this workshop and others related to the barriers to harmonisation, which feed into the analysis here.

242 NOTE: This was not the view of ONRSR representatives, when interviewed. See the Stakeholder Engagement Report (Appendix A) for further information on this interview.

243 NOTE: This conclusion did not achieve universal stakeholder consensus. Instead, a stakeholder noted their belief that, at least on occasion, ONRSR will use RISSB standards as the basis of their audits.

244 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 50.

245 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 9.

information acquisition costs) but likely lowers the level of compliance, decreasing network efficiency and safety. Lack of information sharing also impedes the capability of RIMs to develop a better understanding of the benefits and costs of harmonisation to the networks, and for RIMs to understand where 'quick wins' in standards harmonisation may exist, which is a clear barrier to harmonising[246]. The high coordination costs discourage collaboration, as each RIM may perceive the effort as disproportionate to the immediate benefits they would receive.

Other than RISSB and some other limited forums, some stakeholders also identified that there are limited opportunities and structures for formal, structured, and accountable collaboration across the sector, nor has there been a cultural willingness to share and collaborate.[247]

The exchange of data and knowledge fosters transparency, promotes understanding, and facilitates collaboration among different stakeholders. It enables the alignment of processes, standards, and objectives, thereby driving harmonisation. Where this is not the case, as it is across the Australian rail sector, the opposite is true. Indeed, the lack of effective coordination mechanisms significantly raises the cost and complexity of achieving harmonisation. Coordination requires communication, negotiation, and consensus-building among numerous RIMs, each with its own priorities and constraints.

Conversely, this lack of information sharing is not the case in the EU, where the European Union Agency for Railways (ERA) is responsible for maintaining readily available registers on infrastructure, vehicles, national rules (i.e., non-harmonised standards), and other key technical information[248]. There is no such corollary register in Australia.

Stakeholder Input:

At the RIMs workshop, stakeholder representatives noted that, outside of forums and ventures organised directly by RISSB, there were limited opportunities for formal and structured collaboration between stakeholders in the rail industry. Attendees noted this could be attributed in part to the lack of visibility in information, or the commercially sensitive nature of some information, which limits their ability to be shared freely across jurisdictions. Information sharing was identified as being an technologies have been type approved in other jurisdictions), and in streamlining other processes.

RIMs workshop attendees also believed that there was an existing culture of RIMs being unwilling to collaborate and preferring to operate largely in isolation, within their jurisdiction's best interests. However, it was noted that there has been a recent cultural shift, with an agreement in principle between chief engineers across the NSW, VIC, QLD, and ARTC networks to work towards harmonisation. This cultural shift is due, in part, to the increased national political interest in harmonisation.

Additionally, at the RSOs workshop, attendees believed that standards developed by RISSB are not sufficiently informed by RSOs needs relative to RIMs, and that RSOs are given little opportunity to provide input into their development process. This was attributed to the fact that standards are prioritised and developed largely by RISSB members, and it was believed that there are significantly more RIMs than RSOs represented in the RISSB membership base. Limited collaboration opportunities between different areas within the rail industry (i.e. rolling stock and track) were also noted. Attendees believed that this lack of collaboration and representation of industry in the standards development process has led to gaps in RISSB's set of standards, and thus bespoke standards are required to be developed by RIMs or RSOs to address those gaps. There is also no national system currently in place that facilitates the proactive identification and pursuit of bridging gaps, or addressing inconsistencies, between networks.

Further, the limited sharing of standards information between RIMs and RSOs was a feature of discussion in the ILM workshop. Here, attendees noted that the differences in standards between RIMs are often convoluted and unclear, which is leading to continued fragmentation and deterring potential suppliers from entering the market.

One stakeholder-identified cause of the lack of information sharing and collaboration, is the lack of incentive to do so. This, in turn, being a result of both a lack of funding and resources, as well as a commercially protective mindset based around the ownership of a certain network.

4.2.3 Path Dependency

'Path-dependence' refers to processes where past events and decisions constrain later events or decisions, as development along a certain path becomes increasingly entrenched[249]. Given the history and characteristics of the

246 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 9.

247 See: Stakeholder Engagement Report (Appendix A). Note that this is not a consensus opinion.

248 European Union Agency for Railways. Standards and Interoperability: A European Perspektive. Presentation Slides, 17 November 2023.

249 ScienceDirect. Path Dependence. N.d., https://www.sciencedirect.com/topics/social-sciences/path-dependence.

Australian rail sector, it is also an important barrier to achieving standards harmonisation.

As noted in Section 2.1.1, Australia's rail system has its roots in a highly fragmented history, which has resulted in a textbook example of path dependency. Decisions made in isolation during the 19th and early 20th centuries have long-lasting impacts, as the fundamental infrastructures laid down during this period are not easily or cheaply altered. The initial path taken by each State agency and RIM has created entrenched legacy operational systems and infrastructure, which often lack compatibility with each other, making integration and interoperability more difficult. This has been exacerbated by the continued lack of alignment between industry leaders and those involved in standards development. Importantly, technological path dependency means that investments in old technologies continue to shape current and future technological developments.

Path Dependency: The Example of QWERTY

The concept of path dependency, meaning that inferior standards can persist simply because of the legacy they have built up, is not unique to rail standards. Indeed, the QWERTY keyboard, which has now been acknowledged as an inefficient technical system, is another common example. Here, as for Australian rail standards, decentralised decision-making under path dependency has continued to keep it as the market leader, despite its inefficiency.

As an example of this path dependency, the signalling systems, track design, and electrification standards developed in the past influence which new technologies can be adopted today and into the future. Retrofitting or upgrading these systems (i.e., circuitry and wiring) to a unified standard is prohibitively expensive and logistically challenging, thus perpetuating the current fragmented situation, irrespective of whether the systems are interoperable.

The prevalence of path dependency as a barrier to rail standards harmonisation was illustrated in a 2014 survey of RISSB members, where the most common response for the key impediment to adopting nationally consistent RISSB products related to the established diversity of railway operations and the individual approaches adopted by each rail company[251]. To harmonise standards in the EU, it was also noted that they needed to "get rid of beloved but outdated features".[252]

Furthermore, at the ILM workshop, attendees agreed that the existing and legacy rail infrastructure put in place nationwide acts as a continued barrier to harmonisation as it creates a path dependency problem, and a need for backwards compatibility to accommodate the various technical specifications (i.e. gauges and signalling). Attendees also discussed the impact of legacy infrastructure on procurement and future planning, and the ability to plan for the full lifespan of the asset.

Aside from historical technological incompatibilities, the long lifespan of rail assets and rigid maintenance contracts also contribute towards the path dependency barrier to rail standards harmonisation.

Long Lifespan of Rail Assets

Rail infrastructure and rolling stock have very long lifespans. For example, locomotives today are typically designed for a 25 to 30-year economic life, with a considerable number of 40-year-old or even older locomotives remaining in fleets nationwide[253]. This characteristic significantly contributes to path dependency, as once investments are made, they lock technologies and standards for decades. The long life of rail assets limits opportunities to refine processes or adopt new, nationally harmonised standards. In addition, the process of development to approval is also quite lengthy, which also entrenches the use of long-lasting assets and reinforces the difficulty of harmonising standards across networks.

Rigid Maintenance Contracts

Another aspect of path dependency in Australia's rail system is the rigidity imposed by long-term maintenance contracts with rail equipment suppliers. These contracts often include very specific requirements that are tailored to the technologies and standards in place at the time of agreement[254]. This specificity creates a barrier to harmonisation, as altering these contracts to accommodate new, harmonised standards would involve renegotiation and potentially significant financial penalties.

250 Paul A. David. Clio and the Economics of QWERTY. The American Economic Review, Vol. 75, No. 2, Papers, and Proceedings of the Ninety-Seventh Annual Meeting of the American Economic Association. (May 1985), pp. 332-337.

251 Strategex. A Survey of Rail Industry Safety Standards Board Products. Strategex (for RISSB), 2014. Pg., ii.

252 EULYNX. Digitalisation and Standardisation of Signalling Systems with EULYNX. Presentation Slides, 17 November 2023.

253 Infrastructure and Transport Ministers. Australian Transport Assessment and Planning Guidelines. 2021. Pg., 21

254 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 20.

4.2.4 Nature of Voluntary National (RISSB) Standards

Reflecting RISSB's current role and constrained resourcing arrangements within Australia's voluntary standards regime, its approach to standards development is presently directed by its members in the rail industry who, as outlined in Section 4.2.1, are not incentivised towards achieving standards harmonisation. Indeed, RISSB's *Strategic Plan* and *Annual Work Plan* are endorsed by its members, as well as Governments, which has resulted in RISSB's historical approach to national standard development not being highly strategic and/or necessarily conducive to achieving interoperability, or other standards harmonisation-related benefits.

At the RIMs workshop, attendees also noted that many standards developed by RISSB can be minimally prescriptive in nature, and suggest that a RIM should follow local procedures, or only specify that RIMs should have a standard in place to address that specific issue. Attendees noted that many design standards are not specific and are driven by the performance and operating conditions of individual networks. As a result, RIMs will tailor these standards to optimise outcomes for their respective jurisdictions, which does not necessarily consider interoperability with other networks. An attendee commented that "an Australian standard doesn't exist" due to the non-prescriptive nature of at least some RISSB standards. Indeed, RISSB standards often lack the detail required for design, leading to the development of supplementary guidelines at a local level to provide that guidance, which can cause interoperability challenges even when the same RISSB standards are notionally in use.

Conversely, attendees at the RIMs workshop also noted that they perceived some RISSB standards to not be commercially viable for some networks (i.e. seasonal grain lines). Attendees agreed that standards should be fit-for-purpose, should align with the usage of each unique asset, and that 'blanket' rules led to compromised, or watered down standards; whereby the need to achieve consensus drives down the level at which standards are set to the point that few, if any, entities are non-compliant.[255]

Attendees also noted that RIMs will strongly consider the interests of their organisation when developing standards, which is not always conducive to interoperability. This is as opposed to adopting a harmonised set of RISSB standards that they perceive to not be as viable to their organisation.

Of note, another key point brought up by attendees was that it is not a requirement for all standards to be harmonised to achieve interoperability.

4.2.5 Network Operating Differences

The Australian rail network has diverse operating conditions due to a variety of factors, including varying use profiles and geography. This diversity means that different networks have different standards, especially infrastructure standards, which RSOs must comply with, and that cause complexity in standards development when trying to achieve interoperability. Different commercial settings also impact preferences for standards that align to commercial imperatives.

Further, differences in the operating conditions encountered by each railway were found as one of the biggest barriers to standards harmonisation in RISSB member research, conducted in 2022. 52% of respondents also believed that Australian rail standards, codes of practice, guidelines and rules should primarily reflect their unique local operating conditions[256]. A 2016 RISSB customer satisfaction survey also concluded that the main barriers that RISSB members face with the full implementation of RISSB standards is the inability to align the standards with their specific operations and operating conditions.[257]

Stakeholder Input:

At the RIMs workshop, attendees noted that a key rationale for the use of bespoke standards and barrier to harmonised standards was the existing variations between networks, which leads to different standards being developed. These variations include track geometry requirements and other design specifications, performance and usage of the network, the type of service delivery (i.e., freight vs passenger), as well as the policy and budget committed toward improving rail in each jurisdiction. Attendees agreed that standards should fit the unique needs of each business and that even if all organisations adopted the same standards, then the various existing network interfaces and design requirements would act as a constraint to achieving interoperability.

255 This was also a risk identified by a minority of stakeholders during the 2012 Taig Review. (See: Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 25).

256 Phillips Group. Summary of preliminary findings: RISSB Member Research. Phillips Group (for RISSB), 2022.

257 Insync. RISSB Customer Satisfaction Survey Report. Insync (for RISSB), 2016. Pg., 1

4.2.6 Compliance Costs and Commercial Pressures

A key barrier to standards harmonisation is the cost of changes in standards, which could require RIMs and RSOs to materially change their assets, equipment, and practices to migrate towards compliance with a new, national standard[258]. The cost of upgrades was found to be one of the biggest barriers to standards harmonisation in RISSB member research, conducted in 2022[259]. Aside from the incompatibility of gauges, the standards governing train control systems are the costliest[260], meaning that it is unrealistic to harmonise the standards that govern major assets and systems, given the levels of sunk investment and high costs involved.[261]

However, cost pressures related to standards harmonisation can be mitigated and minimised through appropriate implementation measures. Indeed, standards harmonisation the EU railways in accordance with the TSI framework is not considered to have generated significant costs, given that the TSIs only apply to new vehicles, as well as conditionally applied to renewed and upgraded subsystems[262]. Additionally, government funding could also be provided to overcome RIMs and RSOs cost concerns, while also noting that blank cheques from Government are not a viable solution.[263]

Stakeholder Input:

At the RIMs workshop, attendees noted that resistance to standards harmonisation is partially driven by significant cost constraints and capital expenditure required to change or overhaul current standards being used (see Section 4.2.6), with rolling stock and infrastructure standards being called out specifically in this regard.

At the RSOs workshop, attendees also noted the capital cost for change as being a significant barrier to harmonisation. This is because there is a high level of sunk cost (generally associated with existing/legacy infrastructure and procedures), and there is a longer time horizon for change due to the long asset lives. Attendees noted that these high costs associated with harmonising standards would be shouldered by both RIMs and RSOs, and there would be no incentive to change without government policy or subsidy put in place.

4.2.7 Risk Averse Culture

RIMs, like many key participants in the rail sector, are often risk averse, preferring to maintain the status quo rather than undertake changes that could disrupt operations or incur unforeseen risks, safety concerns, or costs. The perceived risks associated with harmonisation, such as the potential increased safety liabilities, make RIMs hesitant to commit to collective efforts.

Additionally, any change in the standards regime may affect rail sector employees' roles and responsibilities, which could impact on Enterprise Bargaining Agreements (EBAs). And, importantly, any impacts on EBAs are generally avoided by RIMs as much as possible. This is a very strong contributing reason for the risk averse culture and persistent hesitancy to change, irrespective of benefit.

Stakeholder Input:

At the RIMs workshop, attendees noted that there was an existing culture of risk aversion and low risk appetite amongst RIMs, with a lack of a case for change being emphasised as being a key barrier to RIM's willingness to take on the risk of changing the current system.

Further, RSO workshop attendees highlighted the existing culture of risk aversion and scepticism across the rail sector towards changing the current system and developing a harmonised set of standards. This uncertainty and degree of risk if implemented poorly is generally considered unpalatable for stakeholders.

At the rail equipment suppliers' workshop, attendees also noted that there was a culture of risk aversion and a general reluctance to approve products that aligned with non-Australian standards, such as those used in the EU, but have not been used previously in Australia. This was the case even for established technologies that have been used in the EU or elsewhere overseas for decades.

258 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 41.
259 Phillips Group. Summary of preliminary findings: RISSB Member Research. Phillips Group (for RISSB), 2022.
260 Rail Industry Safety and Standards Board (RISSB). Rail Systems Interoperability Guidelines. 2015. Pg., 5.
261 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 23.
262 Cited in: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 20.
263 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 41.

4.3 Risks of Harmonisation

From the external stakeholder workshops with RIMs, RSOs, and rail equipment suppliers, as well as in the key stakeholder interviews and analysis in the existing literature, several key risks of rail standards harmonisation were identified. Also, importantly, workshop attendees agreed that these risks generally arise from ineffective implementation or process of adopting harmonised standards, rather than having harmonised standards themselves. This makes identified risks easier to mitigate than if they were inherent to a process of harmonisation in and of itself.

From the above-described approach, the following key risks of standard harmonisation were identified:

Compromised Standard Quality

RISSB has Insufficient Capacity to Support Harmonised Standards

Key Stakeholder Resistance

Over-Regulation and Lack of Flexibility.

'Wrong' Standards are Harmonised

Governance Risk

Failure to Deliver on a Unified Vision

Each of these risks, as well as some possible high-level, strategic mitigation measures, are all discussed in the subsections below.

4.3.1 Compromised Standard Quality

Explanation and Impact

There is a concern among stakeholders that harmonising standards could lead to a compromise in standard quality, relative to the standards that RIMs currently develop and apply. In part, this risk was identified because the process of reaching a consensus among diverse stakeholders could result in 'watering down' standards to the 'lowest common denominator', which do not adequately address the specific needs of given networks. Additionally, applying 'blanket' harmonised standards may not be suitable for all scenarios, potentially reducing the effectiveness as well as safety of the nation's rail system.

As an example of this risk, a standard that works well in a metropolitan light rail network might not be suitable for a rural freight rail network in a different climate, due to differences in factors like traffic volume, existing network infrastructure, and operational practices. If such differences are not adequately considered, the harmonised standards might fail to meet the specific needs of each network, thereby compromising quality, effectiveness, or safety.

An Alternative View of Risk: The Risk of No Action

At the RIMs workshop, attendees noted that, alongside the risks of proceeding with some form of standards harmonisation, there also exists a risk of not appropriately harmonising standards.

This risk from no or minimal action relates to the broader, whole-of-industry impacts, and the inability of current rail capacity to meet growing freight demand and meet community needs, if harmonisation of some beneficial form is not realised.

There are several possible impacts because of this risk, including the following:

- **Increased Safety Risk:** Lower quality standards may not meet all safety requirements, increasing the risk of safety incidents and accidents. The concern is that in seeking common ground, some critical safety aspects may be overlooked or diluted.
- **Operational Inefficiency:** Standards that are too generic may not optimise rail performance, leading to inefficiencies in operations across the network.
- **Non-Compliance:** RIMs and RSOs might find it difficult to comply with standards that are not fit for their specific purposes, leading to potential non-compliance issues.
- **Unrealised Manufacturing Economies of Scale:** If standards quality is compromised, there could remain several areas of potential difference in design, which would mean that economies of scale benefits are not realised for component manufacturing.

Possible Strategic Mitigations

- Ensure an expert-led collaborative approach to developing standards, maintaining relevant and beneficial local and institutional knowledge. Experts must be able to objectively approach standards development from a national, rather than organisational, perspective – potentially through the inclusion of independent experts.
- Maintain institutional and generational knowledge transfer in standards development, irrespective of the method of harmonisation.
- Implementing a consistent risk management process, and ensuring standards are of high quality.
- In implementation, focus on maintaining flexibility in the network to a variety of technical uses and requirements.

4.3.2 RISSB has Insufficient Capacity to Support Harmonised Standards

Explanation

RISSB's standard development process, although engaging widely with industry stakeholders, also relies heavily on voluntary contributions, predominantly from RIMs. This operating model reflects the role of RISSB within the prevailing regulatory structure, including RSNL, and Australia's voluntary rail standards regime. Importantly, in this current form, RISSB may not have the organisational capacity, including the necessary funding, resources, governance, and expertise, to effectively manage the process of harmonising the requisite quantity of Australian standards in the appropriate manner and to the appropriate quality. Put differently, RISSB is not structured to manage mandated or otherwise enforced rail standards harmonisation because that activity is not within its current remit. Importantly, this fact could hinder the development and implementation of the new, harmonised standards, reducing their effectiveness and delaying the realisation of the benefits of harmonisation outlined in Section 3.

Improved non-mandatory standard quality: The consequence of effective risk mitigation.

If RISSB's capacity is improved to support harmonised standards, this will also have flow-on benefits for the development on non-harmonised standards as well. This is because RISSB could leverage its improved capability for harmonised standards to apply to non-harmonised standards.

Put simply, the process of developing and implementing harmonised standards with widespread adoption requires extensive research, consultation, and coordination efforts. However, given RISSB's current size and resources, the organisation risks struggling to meet these roles in a harmonised standards environment.

There are several possible impacts because of this risk, including the following:

- **Quality Issues:** Limited access to expertise and funding within RISSB in relation to the demands a new, harmonised, rail standards ecosystem may result in lower quality standards and oversight.
- **Compromised Stakeholder Confidence:** Stakeholders may lose confidence in RISSB's ability to lead a harmonisation process, leading to reduced cooperation, engagement, and adoption.

Possible Strategic Mitigations

- Ensuring the involvement of appropriate expertise from external organisations in standard development.
- Additional funding and resourcing for RISSB, as needed to expand capabilities.

4.3.3 Key Stakeholder Resistance

Explanation

The harmonisation of rail standards requires the alignment of various stakeholders, including RIMs, RSOs, and other Government organisations. Each of these entities has developed its own practices, standards, and governance structures over time, especially for RIMs, who can currently develop and apply standards with a high degree of autonomy.

Importantly, the process of harmonisation could lead to a perceived or actual loss of control over these established practices and governance mechanisms. This can result in resistance from stakeholders who fear losing their autonomy, influence, or ability to address specific local needs and issues as they deem appropriate.

There are several possible impacts because of this risk, including the following:

- **Missed Opportunities:** RIMs that feel they are losing control may resist any form of standards harmonisation process or initiative, leading to conflicts and slower progress, with the potential for not capitalising on the opportunity outlined in Section 4.1.

- **Reputational Damage:** Stakeholder resistance and the associated conflicts can damage the reputation of the harmonisation initiative and the entities driving it, leading to a loss of public and industry support.

Possible Strategic Mitigations

- Further integrating current RIMs and regulators into the process of developing harmonised, national standards.
- Ensure that any regulatory, governance, oversight, or other body established in the process of harmonisation adequately represents groups of relevant stakeholders.
- Ensuring transparency of the impacts and benefits of the process, including a potential compensation framework.
- Ensuring that where RIMs and RSOs are government owned, specific harmonisation and interoperability objectives (obligations) are included within their respective corporate objectives, to ensure continued alignment and to minimise resistance over time.

4.3.4 Over-Regulation and Lack of Flexibility

Explanation

Although Australia's co-regulatory environment is arguably too flexible, there is a risk that the opposite becomes true following any process of rail standards harmonisation. Indeed, harmonising standards across a diverse rail network carries the risk of over-regulation, where rigid, one-size-fits-all rules are imposed across diverse networks. Such regulations may not be adaptable or malleable to the specific needs and conditions of different RIMs or RSOs. This lack of flexibility can hinder innovation, efficiency, and the ability to respond to unique operational challenges and local issues, such as a derailment.

In many ways, this risk is the inverse of the risk outlined in Section 4.3.1, as it relates to overly prescriptive harmonised standards, as opposed to 'lowest common denominator' standards that are not prescriptive enough.

There are several possible impacts because of this risk, including the following:

- **Increased / Unnecessary costs:** If a standard is overly prescriptive, then it will cost RIMs and RSOs more to comply with the standards, without receiving a corollary benefit of applying that standard for their operations.
- **Operational Inefficiencies:** Standards that are overly prescriptive and do not account for local variations may lead to inefficiencies, as RIMs or RSOs may be forced to comply with rules that are not optimal for their operating environment.
- **Non-Compliance:** RIMs or RSOs may struggle to comply with inflexible standards, leading to potential legal issues and penalties.
- **Reduced Innovation:** Overly prescriptive standards can stifle innovation by limiting the ability of RIMs or RSOs to experiment with, and implement, new technologies or practices.

Possible Strategic Mitigations

- Include provisions in harmonised standards that allow for individual network derogations and exceptions, where technically or operationally necessary. Here, there could be a presumption of compliance first, then operators who may need to do something different have to justify that, with some centralised body considering the derogation. Importantly, this mitigation in allowing individual networks derogation and exceptions needs justification, to ensure RIMs don't just apply unacceptable derogations.
- Thoroughly engaging with relevant stakeholders, including RIMs, to ensure all standards are of high quality and are relevant to all networks.

4.3.5 'Wrong' Standards are Harmonised

Explanation

In any process of harmonising rail standards, certain standards must be selected to be harmonised, while others are not. In this context, there is the risk of inadequate standard selection, meaning that the 'wrong' standards are chosen to be harmonised. This risk is especially prevalent for emerging technology areas, including decarbonisation-related technologies, where a standard may be selected based on the information available at that time, but another solution could become more broadly adopted by the market. Under this scenario, where the harmonised standards are not the most appropriate to realise the benefits of harmonisation, the benefits of harmonisation would likely not be achieved.

There are several possible impacts because of this risk, including the following:

- **Increased Costs and Risks:** Transitioning to harmonised standards involves costs and risks. If the benefits of harmonisation do not outweigh these costs and risks due to the selection of inappropriate standards, it could lead to financial losses and increased operational risks relative to far smaller gains.
- **Reduced Operational Efficiency:** If the most appropriate standards are not harmonised, the expected improvements in efficiency (through interoperability) may not be realised. This could lead to continued operational challenges and inefficiencies.
- **Limited Economies of Scale and Export potential:** If RIMs harmonise to a single standard in Australia that is substantially different to European or other international standards, this will not enable beneficial access to valuable export markets, or significantly realise economies of scale benefits domestically.
- **Inefficient Resource Utilisation:** The process of harmonising standards requires significant resources, including time, money, and manpower. If the 'wrong' standards are chosen for harmonisation, these resources could be wasted, leading to inefficiencies.

Possible Strategic Mitigations

- Ensure an expert-led collaborative approach to selecting standards for harmonisation, maintaining relevant and beneficial local and institutional knowledge.
- Thoroughly engaging with relevant stakeholders, including RIMs, to ensure all the standards selected to be harmonised will likely achieve the benefits of harmonisation, including the increased export and economies of scale benefits that are achieved through aligning with appropriate international standards.
- Allowing sufficient flexibility for the market to determine the best solution based on needs and industry trends, while ensuring a mechanism to achieve interoperability is effective.

4.3.6 Governance Risk

Explanation

Any process of harmonising rail standards in Australia will involve multiple stakeholders, each with its own governance frameworks, responsibilities, and decision-making processes for developing and applying standards. Establishing a unified governance structure that aligns all these entities, especially if this is done in the context of a modified or heavily revised role for RISSB to address to risk outlined in Section 4.3.2, is complex and fraught with potential issues. As such, 'governance risk' identified here encompasses the challenges of creating a clear, effective, and inclusive governance framework that key stakeholders can agree upon and that can effectively oversee the implementation and continued development and adoption of harmonised standards across networks.

There are several possible impacts because of this risk, including the following:

- **Governance Confusion:** Unclear governance and a lack of an accountable leadership structure can lead to confusion over who is responsible for what; causing misalignment of authority and responsibility, as well as delays and inefficiencies within the regulatory environment.
- **Implementation Delays:** Governance issues can cause significant delays in the implementation of harmonised standards due to unresolved conflicts, slow decision-making, and lack of coordination. Importantly, this also means the potential for not capitalising on the time-bound opportunity outlined in Section 4.1.

Possible Strategic Mitigations

- Clearly define roles and responsibilities in a harmonised standards environment to avoid confusion and overlap. Strategic alignment is required between industry and government.
- Establish a transparent and inclusive decision-making and coordination process that considers the interests of all stakeholders to build trust and cooperation.
- Modify the RSNL to emphasise the objectives of interoperability.

4.3.7 Failure to Deliver on a Unified Vision

Explanation

A unified vision is important for the successful harmonisation of rail standards, as it provides a clear and shared objective that guides all stakeholders through the complex process. Without a unified vision, the efforts to harmonise standards may lack direction, coherence, and momentum. While this vision has been created through the NTC's NRAP, a lack of buy-in across governments and industry players to deliver and maintain the NRAP could lead to fragmented efforts, conflicting priorities, and ultimately, a failure to achieve the desired outcomes and common goals.

There are several possible impacts because of this risk, including the following:

- **Loss of Opportunity:** Efforts to harmonise standards may stall if RIMs do not share a common vision, resulting in the lost possibility of capitalising on the opportunity outlined in Section 4.1.
- **Stakeholder Frustration:** A lack of clear vision can cause frustration among stakeholders including key RIMs and RSOs, leading to decreased cooperation, increased resistance to any harmonisation process, and make consistent, long-term strategic decision-making more difficult.

Possible Strategic Mitigations

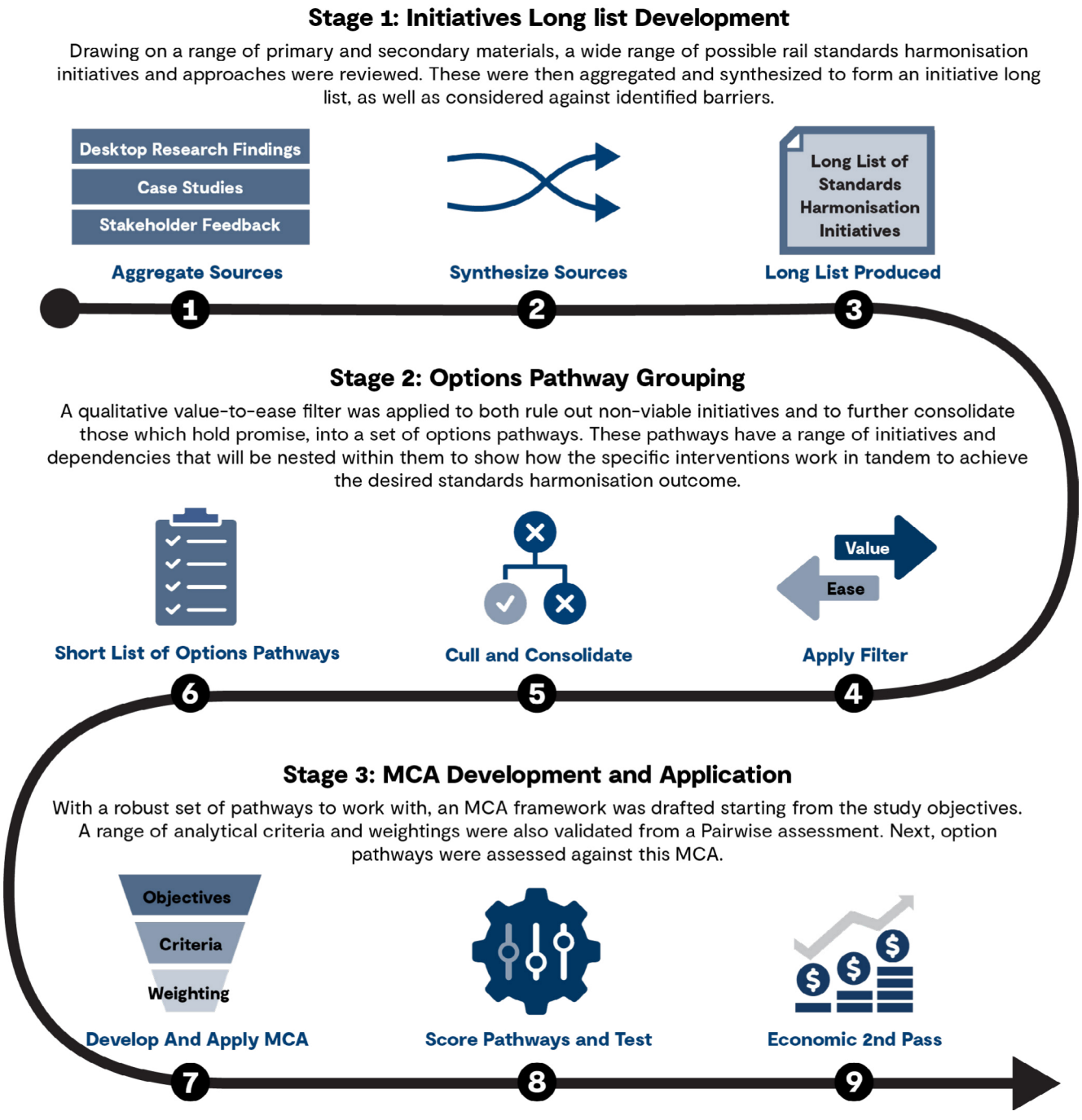
- Ensure that RIMs and other key stakeholders take ownership of the strategic narrative and justification behind any process of rail standards harmonisation.
- Ensure that objectives and processes for standards harmonisation are aligned amongst RIMs.
- Ensure that industry and government are in alignment and leverage the current political momentum (including that created through the NRAP).

5. Harmonisation Option Pathways

5.1 Methodology and Approach

Given the identified opportunities, barriers, and risks of rail standards harmonisation (Section 4), as well as to realise the benefits identified in the case for harmonisation (Section 3), several harmonisation-related initiatives and related options have been developed and assessed. To thoroughly consider the extensive standards harmonisation evidence base and assess options, a three-tier evaluation process was used, as outlined in Figure 17.

Figure 17 Options development and assessment methodology



5.2 Initiatives Long List

As per the methodology and approach outlined in Figure 17, a long list of harmonisation advancement initiatives has been identified and defined based on a combination of stakeholder input, previous reviews, and research. This includes the following source material:

- The outcomes of the Investment Logic Mapping exercise (see the Stakeholder Engagement Report at Appendix A), with a focus on strategic response identification.
- Stakeholder engagement including offered approach suggestions from tranche 1 workshops and one-on-one meetings.
- Preliminary strategic initiatives indicated in the submitted draft chapters of the report and informed by a wide literature review.
- Suggested considerations and initiatives from the GHD internal technical team, as informed by their international experience.
- The recommendations of the Taig Review (2012).
- Cross-domain expertise, from standard harmonisation processes in sectors such as mining and agriculture.

Initiatives are generally not mutually exclusive although some may conflict. Many also remain as 'no regrets' initiatives, which would be logical contributors under any harmonisation advancement pathway.

The long list of 12 initiatives identified and considered (which are of varying expected influence and costs) are listed as follows, mapped in Table 9 against the identified barriers to harmonisation in Section 4.2, to see which barriers that initiatives directly respond to. Note that initiatives are still considered at the concept level, meaning specifics of what each strategic initiative looks like in practice have room for variability.

Further initiative detail, as well as a strategic analysis of these initiatives in terms of their benefits, challenges and issues, and other informing considerations, is also provided at Appendix B. Stakeholder feedback on each initiative is also recorded in Chapter 6 of the Stakeholder Engagement Report at Appendix A. This detailed analysis and input is an important consideration that has deeply informed the development of option pathways.

Table 9 Initiatives long list against identified barriers to harmonisation

Capability requirement	Barriers							Explanation
	Minimal incentive to change	Lack of information sharing and collaboration	Path dependency	Nature of Voluntary National (RISSB) Standards	Network Operating Differences	Compliance Costs and Commercial Pressures	Risk Averse Culture	
Greater government and industry alignment and promotion of voluntary adoption and implementation.		x						Encourages RIMs collaborate on the implementation of standards.
Establish a central directory or database for high benefit standards.		x						A central directory would serve as a knowledge hub, improving access to information and fostering collaboration.
Greater harmonisation-specific stakeholder collaboration forums and technical working groups.		x					x	Encourages sharing of best practices and collaborative problem-solving, which can break down information silos and mitigate risk aversion by fostering a collective and open approach.

Capability requirement	Barriers							Explanation
Incentive programs for early harmonised standards adopters.	x		x			x	x	Provides a tangible benefit for early adoption, making the prospect of change more attractive financially and commercially.
Regulation to mandate a limited range of specific standards.	x		x					Introduces a legal obligation that requires RIMs and RSOs to comply with select standards, overriding the inertia of path dependency.
Mandatory disclosure of derogation for non-standard projects and system changes.	x		x					Introduces a mandatory requirement that more greatly incentivises RIMs and RSOs to comply, working to override the inertia of path dependency.
Government support for industry in meeting the cost of change to comply with new standards.	x		x			x	x	Alleviates the financial burden of transitioning to harmonised standards, making it a more attractive and less risky option. Also working against institutional inertia through incentives.
Project investors (governments) refusing to finance projects not using specific harmonisation standards.	x		x					Creates a strong commercial imperative for moving towards harmonisation by linking it to a key source of project financing.
Develop a formal automatic mutual recognition scheme for rollingstock and adopt national type approval framework with associated formal agreements.	x	x	x					Introduces a commercial incentive to change, working to overcome path dependence, while encouraging information sharing between stakeholders.
Undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation.	x	x	x	x	x	x	x	Review would support the development of any given harmonisation pathway, including how to improve the nature of RISSB standards, ensuring they are fit-for-purpose and aligned with strategic and commercial goals.
Mandate that national training units of competency, skills sets and qualifications be delivered in the context of a generic railway, which is supported by a Guidance document.		x						Initiative fosters a unified and collaborative approach to staff training across rail networks.
Government investment in type approval technologies that help solve standards-related interface constraints.					x			New technologies that help solve standards-related interface constraints, would help to overcome existing operational differences.

5.2.1 Content of Harmonised Standards

The initiatives outlined in Table 9 occasionally refer to 'high benefit' standard areas. This reflects that the initiatives are focussed on an 'optimum' level of harmonisation in select areas, as opposed to across-the-board harmonisation for its own sake. For the avoidance of doubt, these high benefit areas are indicatively considered as being select standards in the following groups of standards:

- Train Control Command and Signalling.
- Rolling Stock Components and Approvals.
- Type Approval (TA).
- Telematics Applications for Freight Services.

These indicative groups of standards have been identified based on an assessment of the relative merit of harmonising the groups of standards to achieve the benefits outlined in Section 3, relative to the indicative cost to stakeholders of harmonising – "benefits at least cost". For example, infrastructure standards (i.e., track geometry) are not included in the list because, although they would be highly beneficial to harmonise, the relative cost would be prohibitive and negate the benefits. This was also noted in the Taig Review, which concluded that "it is unrealistic to try and harmonise major assets and systems given the levels of sunk investment involved". Instead, "more effort should go into harmonising operations with those diverse assets and/or into harmonising at component level". This was a major theme of the EU TSIs (see 'EU lessons learned' below).[264]

EU Lesson Learned: Prioritisation for standard setting

When undergoing its process of rail standards harmonisation, the EU focused interoperability on a range of standards with some being mandatory, whilst others remained voluntary. Digital signalling and train communications have been a specific focus (GSM-R and ETCS), alongside aligning standards for rail freight, to drive interoperability. For example, as late as 2016, freight trains travelling from Poland through to the UK would need up to seven separate communication systems as they traversed jurisdictions. The GSM-R program is gradually streamlining these train communication systems, as well as being an integral component of ETCS.

Similarly, in Australia, given the major focus on freight interoperability, and the need to streamline the roll out of digital signalling and train communication systems, these should likely be the focus of any mandatory centralised standard setting process.

Consideration has also been given to direct stakeholder input, which consistently highlighted TA, rolling stock, and signalling, as the most important standard areas to harmonise (see 'stakeholder input' below and the Stakeholder Engagement Report at Appendix A). Additionally, alignment in the content of harmonised standards was also sought with international best practice through the groups of standards that are considered in the EU TSIs (see Section 2.3.1).[265]

Furthermore, consideration has been given to the economic analysis of standards harmonisation (see Section 7). In this analysis, the quantitative benefits of standards harmonisation centrally follow from an increased mode shift towards rail (through interoperability, which is largely reliant on train control command and signalling) and a more streamlined TA process. As such, these groups of standards have also been identified as high benefit groups of standards to harmonise.

Stakeholder Input: Understanding where best to harmonise

At the Options workshops[266], stakeholders identified that some initiatives were dependent on the harmonisation of standards in key areas. For example, the mandatory disclosure of derogations requires a degree of harmonisation to be able to identify which projects have derogations. For many other initiatives, the effect is largely dependent on which standards are harmonised. As such, undertaking a gap analysis to understand and account for all differences between standards used across jurisdictions would be beneficial in understanding which standards are best to harmonise at each stage of the harmonisation process.

5.3 Option Pathways Developed

Achieving the harmonisation of rail standards in Australia is a complicated and layered task, necessitating meticulous planning, collaboration, and a dedication to long-term strategic goals. Therefore, addressing harmonisation challenges and ensuring the successful rollout of effective strategies demands a thorough action plan, including both short-term and long-term measures and initiatives.

Standards harmonisation will be a long and continual journey, not a singular event. This has been the case in other jurisdictions as well. In the EU, the process of standards harmonisation began in the early 1990s, with little solid development until 2016. Improvements have been slow for rolling stock and infrastructure, partly owing to their long-life nature, as well as uneven across jurisdictions – a fact that remains today[267]. And Australia today is in the same position as the pre-2016 EU, with fragmented rules, closed markets, localised authorities, and low innovation. As such, there remains a long pathway to a more harmonised rail standards ecosystem.

264 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 23.

265 European Union Agency for Railways. Technical Specifications for Interoperability. ERA, n.d., https://www.era.europa.eu/domains/technical-specifications-interoperability_en

266 See: Stakeholder Engagement Report (Appendix A).

267 European Union Agency for Railways. Report on Railway Safety and Interoperability in the EU. ERA, 2022. Pg., 64

Considering the above important considerations, option pathways (not just 'options') have been developed to achieve consistent adoption of international and Australian standards.

Stakeholder Input:

At the Options workshops[268], consistent feedback from stakeholders was that no initiative should be implemented in isolation. The most effective outcomes would be achieved through a targeted combination of multiple initiatives. For example, stakeholders suggested that the initiatives for regulation to make standards compliance mandatory and the mandatory disclosure of derogations should be combined with more positive financial incentives to maximise engagement. Stakeholders believed that there was a need for mandating to drive practical change, and that it was a 'necessary prerequisite' for achieving a harmonised set of standards and interoperability.

In considering rail standards harmonisation option pathways, there is a broad policy dichotomy that is apparent, between the voluntary promotion of harmonised standards, against the legal mandating of standards with associated enforcement. The broad dichotomy can be defined as follows:

- **Voluntary Standards:** The current regulatory framework in Australia. RISSB or other agencies can produce national standards and positively promote these products, but RIMs and RSOs have the ultimate authority and prerogative whether they are enacted.
- **Mandatory Standards:** The current regulatory framework (in different varieties) in the EU and USA. Select 'high benefit' standards are imposed on RIM and RSO equivalents to achieve the benefits identified from nationwide rail standards harmonisation (see Section 3).

Given the current regulatory regime in Australia is voluntary under co-regulation, ***Option 1: Voluntary Pathway*** has been developed as an 'enhanced status quo', with minimal regulatory change. Under this option pathway, harmonised standards would be co-designed by industry in high-benefit standard areas and using international precedents, with supporting incentive mechanisms. This co-design would be supported by strengthened governance architecture and industry collaboration mechanisms. This option pathway aims to foster a cooperative environment where the voluntary adoption of standards is rewarded, guided by strong governance and supported by incentives to stimulate industry participation. In terms of timing, this option pathway would take less than 10 years to implement in full, with the timeline for the realisation of full benefits depending on option efficacy.

To compare to the voluntary option pathway, two mandatory pathways have been developed. These pathways reflect a divergence in regulatory theory surrounding government enforcement, around the dichotomy between the following 'schools of thought':

- **Gradualism:** Represents a philosophy that values incremental change and adaptability within the regulatory framework. It suggests that mandatory standards can be effectively integrated into the system over time, focusing on new equipment and systems, and providing a structured transition that respects the diversity of the regulated entities' capabilities and resources.
- **Interventionism:** Represent a philosophy that aligns with regulatory theories that advocate for strong government action to ensure more rapid compliance with mandatory standards, especially when there are significant public interests at stake. The approach calls for a stringent mandate with time-bound compliance, supported by substantial government funding to mitigate the financial burden on those impacted by the new regulations.

In essence, the dichotomy reflects a balance between the need for regulatory certainty and the benefits of regulatory flexibility. It highlights the tension between the desire for swift progress in harmonisation and the practical considerations of industry readiness and financial constraints. Both approaches are rooted in the broader discourse on how best to design and implement mandatory rules in a free market, considering factors such as efficiency, fairness, and the distribution of costs and benefits.

Considering the gradualist approach, ***Option 2: Gradualist Mandatory Pathway*** has been developed. Under this option pathway, there would be mandatory rail standard harmonisation across high-benefit standards areas and complete with technical specifications. This option pathway will prioritise the grandfathering of effective solutions, only apply to new equipment and systems, will be multi-year, and have a range of approved derogation areas. The option pathway aims to enforce a selective mandate that targets areas with the greatest potential for benefit while providing a structured transition period and accommodating exceptions where necessary. The option pathway has been heavily informed and influenced by the EU's experience of implementing mandatory standards harmonisation, through the EU TSIs. In terms of timing, this option pathway would take approximately five to 10 years to implement in full, with full

268 See: Stakeholder Engagement Report (Appendix A).

benefits not being realised until 25 to 30+ years after implementation, given the long life of rail assets in tandem with the grandfathering approach.

Additionally, considering the interventionist approach, ***Option 3: Interventionist Mandatory Pathway*** has been developed for assessment. Under this option pathway, there would be a phased transition of a stringent mandate for rail standards harmonisation across both new and some existing rail equipment, with minimal grandfathering arrangements for high benefit standard areas. To assist with the rapid transition resulting from the mandates, high levels of government funding (subsidisation) would be available to those that bear costs and make the pathway more viable. In terms of timing, this option pathway would take approximately 5 years to implement in full, with full benefits not being realised until 20 years after implementation, due to the need for a reasonable implementation timeframe, even without grandfathering.

These three above option pathways are defined by a package of the initiatives that constitute them, in line with their overarching parameters. This packaging is outlined in Table 10 overleaf. Note that similar initiatives are apparent in option pathway 2 as option pathway 3, given both involve mandating. The difference is in the speed (timeline) and the extent to which harmonisation is mandated and implemented.

Additionally, some initiatives are common to all options. These initiatives are the 'no regrets' initiatives that are considered beneficial and low risk under each option pathway.

Also important to note, each of these option pathways will require top-down political alignment, as well as a gradual and concrete implementation roadmap with prescribed responsibilities, so that stakeholders have time to react. This is a key 'facilitating factor' for meaningful change.

Following Table 10, each option pathway is defined with greater specification of an indicative timeframe and option-specific initiative implementation considerations[269]. Note that each option pathway has packaged initiatives containing at least one initiative that responds to every identified barrier to harmonisation in Section 4.2.

Table 10 Packaging initiatives into option pathways

Initiative	1 – Voluntary Pathway	2 – Gradualist Mandatory Pathway	3 – Interventionist Mandatory Pathway
Greater government and industry alignment and promotion of voluntary adoption and implementation.[270]	✓		
Greater harmonisation-specific stakeholder collaboration forums and technical working groups.	✓		
Incentive programs for early harmonised standards adopters.	✓		

269 NOTE: General implementation and supporting considerations for each initiative are contained in the initiative long list 'strategic analysis' at Appendix B.

270 NOTE: This initiative is not considered in mandatory option pathways 2 and 3, because greater harmonisation-specific stakeholder collaboration forums and technical working groups are not necessarily aligned with mandatory harmonisation, but instead are subject to the outcome of the important review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation (another initiative). Put differently, there is the potential that they might not be required if there is greater focus on in-house standards development within RISSB, while also noting that a level of continued industry involvement is fundamental to assure stakeholder buy-in and standard quality.

Initiative	1 – Voluntary Pathway	2 – Gradualist Mandatory Pathway	3 – Interventionist Mandatory Pathway
Establish a central directory or database for high benefit standards.	√ Permanent directory / database for RIMs and RSOs to voluntarily access and apply.	√ Transitory measure in slower transition to mandating, until high benefit standards are mandated and public and database is no longer required.	
Regulation to mandate a limited range of specific standards.		√ A less expansive set of harmonised standards than 'interventionist'. Slower implementation timeframe. Grandfathering, applying to only new systems.	√ A more expansive set of harmonised standards than 'gradualist'. Quicker implementation timeframe. Retrospectively applied in places, with a phase in process.
Mandatory disclosure of derogation for non-standard projects and system changes.		√ Supports transition in a mandatory context. Applies to a less expansive set of harmonised standards.	√ Supports transition in a mandatory context. Applies to a more expansive set of harmonised standards.
Government support for industry in meeting the cost of change to comply with new standards.		√ Funds required to ensure 'none worse-off' from applying national standards.	√ Significant funds required, given backdating and relatively rapid transition.
Project investors (governments) refusing to finance projects not using specific harmonisation standards.		√ Looser conditions and likely more curtailed funds, as opposed to withholding.	√ Strict conditions with quick implementation timeframe.
Develop a formal automatic mutual recognition scheme for rollingstock and adopt national type approval framework with associated formal agreements.	√ Initiative to be pursued, pending a voluntary agreement on what is mutually recognised. May be non-binding MoU	√ Linked to corollaries of the mandated standards.	√ Linked to corollaries of the mandated standards.
Undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation.	√ Less important to the voluntary pathway than mandatory pathways, as less changes are made relative to mandating pathways.	√ Necessary to support the transition to implement and delivery a gradualist mandatory standards regime, including by defining the capability and role of RISSB, as well as how best to develop mandatory standards, and how to enforce mandatory standards.	√ Necessary to support the transition to implement and delivery an interventionist mandatory standards regime, including by defining the capability and role of RISSB, as well as how best to develop mandatory standards, and how to enforce mandatory standards.

Initiative	1 – Voluntary Pathway	2 – Gradualist Mandatory Pathway	3 – Interventionist Mandatory Pathway
Mandate that national training units of competency, skills sets and qualifications be delivered in the context of a generic railway, which is supported by a Guidance document.	✓ Initiative to be pursued, pending a voluntary agreement on the national training units of competency, skills set, and qualifications that are delivered in the context of a generic railway.	✓ Linked to corollaries of the mandated standards.	✓ Linked to corollaries of the mandated standards.
Government investment in type approval technologies that help solve standards-related interface constraints.	✓	✓	✓

5.3.1 Option Pathway 1 – Voluntary Pathway

Table 11 Option Pathway 1 – Voluntary Pathway

Initiative	Indicative timeframe	Option-specific supporting considerations
Greater government and industry alignment and promotion of voluntary adoption and implementation.	< 2 years Greater promotion can be ramped up over time.	– RISSB to internally lead promotional activities highlighting the benefits of voluntary adoption. – RISSB to commission an external, 'outside-in', whole-of-industry review of all its standards, to determine if full uptake is conducive to achieving interoperability. – RISSB to undertake a review of processes, to determine how they can better produce 'fit-for-purpose' outcomes. – Funding to be sought from the Commonwealth, as opposed to increased fees for RISSB members (subject to viability).
Greater harmonisation-specific stakeholder collaboration forums and technical working groups.	< 2 years	– Funding for appropriate resourcing (i.e., secretariate, mediator, and other defined roles) to be sought from the Commonwealth, as opposed to increased fees for RISSB members (subject to viability). – Set up regular forums and working groups to discuss harmonisation efforts, with buy-in and commitment from senior levels of industry. Encourage active participation and sharing of best practices among stakeholders.
Government investment in type approval of technologies that help solve standards-related interface constraints.	< 2 years For funding program establishment and first recipients.	– Funding to be apportioned through direct engagement with industry and engagement with existing TA channels, or through developing its own TA process (pending recognition of this process by RIMs and RTOs). The decision on implementation will be the prerogative of the funding agency and Department (Commonwealth).

Initiative	Indicative timeframe	Option-specific supporting considerations
Undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation.	< 2 years Full governance review will need to occur after option pathway and roadmap defined.	– Conduct a thorough review to identify areas where governance and supporting arrangements can be strengthened, even as the approach remains voluntary. – Review should consider the appropriate role of RISSB and associated requirements on its capability, given its expanded role in a voluntary environment. – Review should determine ownership of a 'clear vision' behind voluntary harmonisation. – Appoint a dedicated team to conduct the review and engage with stakeholders to gather input and build consensus on proposed changes.
Incentive programs for early harmonised standards adopters.	< 5 years	– Design incentive programs that provide tangible benefits for early adopters, as well as scalable, allowing for expansion as more entities join the harmonisation effort. – Ensure that the incentives are meaningful enough to motivate change, as well as drive real behavioural changes. – Funding to be sought from the Commonwealth, to be directed at (largely) State Governments, as an extension of the RIMs.
Establish a central directory or database for high benefit standards.	< 5 years	– Create a comprehensive and user-friendly database for easy access to high benefit standards. – Ensure regular updates and maintenance of the database to keep it relevant, including proactive identification and pursuit of bridging gaps, or addressing inconsistencies. – Consider roles and responsibilities of the central directory / database as part of the governance review initiative. Without ownership, the initiative will be ineffective.
Mandate that national training units of competency, skills sets and qualifications be delivered in the context of a generic railway, which is supported by a Guidance document.	< 7 years	– Collaborate with educational institutions to develop training that aligns with the harmonised standards. – Certify trainers and assessors to deliver the training effectively. – Address geographic-specific concerns of stakeholders, as and when they arise.
Develop a formal automatic mutual recognition scheme for rollingstock and adopt national type approval framework with associated formal agreements.	< 10 years	– Can only be implemented after a voluntary agreement on common standards that govern rollingstock approvals and TA. – Legal and governance framework will be needed to support mutual recognition, which specifies who would oversee approvals. Could be implemented using a new government body, or through the modified responsibility of an existing entity.

Further key characteristics related to this voluntary option pathway include the following:

– **Collaborative Standard Development and Enactment:** The heart of this option is the collaborative development of standards without a mandate. It's about further leveraging collective industry expertise to create standards that are not only technically sound but also widely applicable and accepted, without the step to mandate them.

- **Incentive-Driven Adoption:** Unlike mandates, this approach relies on positive reinforcement driven by industry stakeholders. It is focused on creating an environment where compliance with a national standard is not just a regulatory requirement but part of a shared, collaborative, and national vision for the rail sector.
- **Governance as a Facilitator**: Governance in the context of this option pathway, acts less as an enforcer and more as a facilitator and mediator. It's about providing the structure and support necessary for voluntary and stakeholder-led initiatives to thrive.

5.3.2 Option Pathway 2 – Gradualist Mandatory Pathway

Table 12 Option Pathway 2 – Gradualist Mandatory Pathway

Initiative	Indicative timeframe	Option-specific supporting considerations
Government investment in type approval of technologies that help solve standards-related interface constraints.	< 2 years For funding program establishment and first recipients.	– Funding to be apportioned through direct engagement with industry and engagement with existing TA channels, or through developing its own TA process (pending recognition of this process by RIMs and RTOs). The decision on implementation will be the prerogative of the funding agency and Department (Commonwealth).
Regulation to mandate a limited range of specific standards.	Legislation 1-2 years, effective within 5-10 years.	– A less expansive set of harmonised standards and slower implementation timeframe, compared to option pathway 3. – Strong grandfathering approach, with the mandate not applying to in-flight projects. – Develop a clear timeline and roadmap for compliance and rollout, as part of a national Strategy. – Establish a monitoring and enforcement mechanism to ensure adherence (such as through an expanded role for ONRSR). – Use international standards, or otherwise existing national and bespoke standards, as the mandated standards, where available and relevant. – Clarify liability issues and address in the legislation. – Develop strong process for developing and testing the standards, before mandating.
Mandatory disclosure of derogation for non-standard projects and system changes.	In line with mandated standards (once effective).	– Strong grandfathering approach, with mandate disclosure not applying to in-flight projects. – Set up a transparent process for applying and granting derogations. – Define strict criteria to qualify for derogations to maintain the integrity of the harmonisation process and to ensure the benefits of harmonisation are still realised. However, this approach would be more lenient than for option pathway 3. – Approved derogations are, wherever possible, accompanied by a time bound and enforceable and auditable plan to work towards future compliance. This timeline would be more gradual than for option pathway 3.
Government support for industry in meeting the cost of change to comply with new standards.	In line with mandated standards, for a maximum 7-year period.	– Create a funding framework that details the eligibility, application, and disbursement process. – Ensure RIMs are 'not losers' from applying national standards. – Funding runs in parallel to mandatory standards implemented. – Decision on implementation will be the prerogative of the funding agency and Department (Commonwealth).

Initiative	Indicative timeframe	Option-specific supporting considerations
Undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation.	Review within 18 months, fully enact within 5 years.	– Review should promote an appropriate set of governance arrangements, such as an expanded role of ONRSR, to implement and deliver harmonised standards in a gradualist way. – Appoint a dedicated team to conduct the review and engage with stakeholders to gather input and build consensus on proposed changes. – Would need to consider a mechanism to prevent the system from being 'gamed' by market participants.
Develop a formal automatic mutual recognition scheme for rollingstock and adopt national type approval framework with associated formal agreements.	Mandatory areas to be in place within 3-5 years.	– Develop once the mandated standards to harmonise have been defined, as this will inform. – Legal and governance framework will be needed to support mutual recognition, which specifies who would oversee approvals. Could be implemented using a new government body, or through the modified responsibility of an existing entity. – Initiative progressed by the NTC and realised in part with Government support for the RISSB National Rollingstock Register project.
Establish a central directory or database for high benefit standards.	< 5 years, phasing out as mandating increases.	– Phased out as standards are mandated. – Create a comprehensive and user-friendly database for easy access to high benefit standards. – Ensure regular updates and maintenance of the database to keep it relevant, including proactive identification and pursuit of bridging gaps, or addressing inconsistencies. – Consider roles and responsibilities of the central directory / database as part of the governance review initiative. Without ownership, the initiative will be ineffective.
Mandate that national training units of competency, skills sets and qualifications be delivered in the context of a generic railway, which is supported by a Guidance document.	< 5 years	– Linked to corollaries of the mandated standards, which are less wide-reaching than for option pathway 3. – Collaborate with educational institutions to develop training that aligns with the harmonised standards. – Certify trainers and assessors to deliver the training effectively. – Address geographic-specific concerns of stakeholders, as and when they arise.
Project investors (governments) refusing to finance projects not using specific harmonisation standards.	> 5 years	– Target government funding towards new projects that comply with the harmonised standards, leaving existing developments in accordance with the grandfathering approach. – Integrate harmonised standards compliance checks early into the project funding approval process (i.e., during the Business Case phase). – Minimal to some derogations for not using mandatory standards allowed.

Further key characteristics related to this gradualist option pathway include the following:

- **'Optimum' Harmonisation:** By focusing on areas with the greatest impact on interoperability and rollingstock, this option aims to maximise the benefits of standardisation where it counts the most (see Section 5.2.1). This selective 'optimum' approach can lead to significant improvements in efficiency and safety, without overwhelming, unnecessary, and costly changes being imposed on industry. However, it is important to note that this 'optimum' balance of what standards are beneficial to harmonise, and which are not, requires a holistic, strategic view, as well as a degree of subjectivity from the relevant mandating authority.
- **New Equipment and Systems Only (Grandfathering):** Limiting the mandate to new equipment and systems allows for a forward-looking strategy that does not penalise existing operations that are compliant with the current regulatory regime. It does, however, delay benefit realisation.
- **Multi-year Transition:** A structured transition period acknowledges the time required for industry adaptation and avoids the pitfalls of rushed implementation. It provides a realistic timeframe (informed by the EU TSI experience) for RIMs and RSOs to plan and execute the necessary changes.
- **Government's Role:** The government's role in this option is crucial, not only in enforcing the mandate but also in providing support and incentives. This dual role of a 'carrot and a stick' helps balance the regulatory push with the necessary pull of financial and technical assistance for RIMs.

Overall, this option presents a pragmatic yet ambitious path towards harmonisation, with a clear focus on areas that will deliver the most significant benefits. It recognises the complexities of the industry and seeks to introduce changes in a way that is both manageable for the stakeholders and beneficial for the future of rail transport in Australia.

5.3.3 Option Pathway 3 – Interventionist Mandatory Pathway

Table 13 Option Pathway 3 – Interventionist Mandatory Pathway

Initiative	Indicative timeframe	Option-specific supporting considerations
Government investment in type approval of technologies that help solve standards-related interface constraints.	< 2 years For funding program establishment and first recipients.	– Funding to be apportioned through direct engagement with industry and engagement with existing TA channels, or through developing its own TA process (pending recognition of this process by RIMs and RTOs). The decision on implementation will be the prerogative of the funding agency and Department (Commonwealth). – Costs could potentially be lower if there is a more singular direction for technological solutions (and related standards) under a more interventionist mandate.
Regulation to mandate a limited range of specific standards.	Legislation 1-2 years, effective in 2-5 years	– A more expansive set of harmonised standards and quicker implementation timeframe, compared to option pathway 2. – Develop a clear timeline and roadmap for compliance and rollout, as part of a national Strategy. – Establish a monitoring and enforcement mechanism to ensure adherence (such as through an expanded role for ONRSR). – Use international standards, or otherwise existing national and bespoke standards, as the mandated standards, where available and relevant. – Clarify liability issues and address in the legislation. – Develop strong process for developing and testing the standards, before mandating.

Initiative	Indicative timeframe	Option-specific supporting considerations
Mandatory disclosure of derogation for non-standard projects and system changes.	In line with mandated standards (once effective).	– Set up a transparent process for applying and granting derogations. – Define strict criteria to qualify for derogations to maintain the integrity of the harmonisation process and to ensure the benefits of harmonisation are still realised. However, this approach would be more stringent than for option pathway 2. – Approved derogations are, wherever possible, accompanied by a time bound and enforceable and auditable plan to work towards future compliance. This timeline would be less lenient than for option pathway 2.
Government support for industry in meeting the cost of change to comply with new standards.	In line with mandated standards (once effective), for a maximum 5-year period.	– Create a funding framework that details the eligibility, application, and disbursement process. – Ensure that the support is timely and adequate to meet the needs of RIMs during the transition. – Funding runs in parallel to mandatory standards implemented. – Ensure funding allocation is substantial, to account for the speed of change under this option pathway. – Decision on implementation will be the prerogative of the funding agency and Department (Commonwealth).
Project investors (governments) refusing to finance projects not using specific harmonisation standards.	No earlier than 3 years	– Communicate the financial implications of non-compliance to all stakeholders early in the project lifecycle (i.e., during the Business Case phase). – No to minimal derogations for not using mandatory standards allowed.
Develop a formal automatic mutual recognition scheme for rollingstock and adopt national type approval framework with associated formal agreements.	Mandatory areas to be in place within 2-3 years	– Develop once the mandated standards to harmonise have been defined, as this will inform. – Legal and governance framework will be needed to support mutual recognition, which specifies who would oversee approvals. Could be implemented using a new government body, or through the modified responsibility of an existing entity. – Initiative progressed by the NTC and realised in part with Government support for the RISSB National Rollingstock Register project.
Undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation.	Review within 18 months, fully enact within 3 years	– Review should promote an appropriate set of governance arrangements, such as an expanded role of ONRSR, to implement and deliver harmonised standards in an interventionist way. – Appoint a dedicated team to conduct the review and engage with stakeholders to gather input and build consensus on proposed changes. – Would need to consider a mechanism to prevent the system from being 'gamed' by market participants.

Initiative	Indicative timeframe	Option-specific supporting considerations
Mandate that national training units of competency, skills sets and qualifications be delivered in the context of a generic railway, which is supported by a Guidance document.	Install within 3 years.	– Linked to corollaries of the mandated standards, which are more wide-reaching than for option pathway 2. – Collaborate with educational institutions to develop training that aligns with the harmonised standards. – Certify trainers and assessors to deliver the training effectively. – Address geographic-specific concerns of stakeholders, as and when they arise.

Further key characteristics related to this interventionist option pathway include the following:

- **Minimal Grandfathering Arrangements:** The minimisation of grandfathering arrangements means that, when a given national standard is developed and then implemented, it will apply to some existing equipment, which must then be brought up to the current standards. This may pose significant challenges for RIMs but is essential for expediting a uniform standard regime across the network. Conversely, it will expediate benefit realisation.
- **Government Subsidisation:** The provision of government funding is a critical component that acknowledges the financial impact of the mandate on stakeholders. It serves as a cushion against the costs of upgrading or replacing non-compliant equipment, even under a more 'aggressive' implementation option pathway. That said, this approach will make the option very expensive to Government.
- **Operational Challenges:** The rapid transition may present operational challenges, particularly for RIMs with extensive networks and diverse equipment. Careful planning and phased implementation can help mitigate these challenges.
- **Stakeholder Support:** Under this strict option pathway, ongoing stakeholder engagement and buy-in remain crucial. It ensures that the concerns and suggestions of industry participants are considered and addressed, especially under a more aggressive implementation pathway.

Ultimately, this option pathway represents a bold move towards rail standards harmonisation in Australia. It requires a significant investment of time, resources, and effort from all parties involved but promises to more quickly deliver a less fragmented and more efficient rail system that benefits the entire country. The rapid transition, however, poses increased risks and exposure to unintended consequences, including likely service disruption.

5.4 Multi-Criteria Analysis (MCA)

The Multi-criteria Analysis (MCA) approach was selected to assist with the complex decision-making process involved in selecting a 'preferred' option pathway to expand upon.

5.4.1 Criteria and Approach

To assess and compare option pathways, an MCA framework was developed. Provided at Table 14, the MCA framework sets out six (6) criteria against which the three option pathways were compared, analysed, and filtered. Also included are weighting values, which are the aggregate of a Pairwise assessment undertaken with representatives of ARA, NTC, ONRIC, and RISSB.

Table 14 MCA evaluation criteria as they relate to assessing options

Criteria #	Criteria name / title	Criteria description	Weighting
1	Cost	This criterion considers the relative financial implications of adopting each option pathway. It includes consideration of direct costs to RIMs, RSOs, and Governments (such as through subsidising) including equipment upgrades, training, and system overhauls, as well as indirect costs like operational disruptions and potential increased compliance costs for rail operators during the transition period. The assessment should consider both short-term expenditures to stakeholders as well as long-term financial impacts. A harmonisation option pathway is considered lower cost if there are fewer mandatory provisions, slower transition, less likelihood for sunk investment, stranded assets and lower likely impact on operating costs.	18.15%
2	Certainty	This criterion measures the probability that the expected benefits of harmonisation will be achieved. It considers the robustness of each option pathway's framework, the extent of regulatory support, the historical success rates of similar initiatives, and the legal and regulatory framework that must be modified. The certainty is higher when the pathway has clear, enforceable mandates, and lower when it relies on voluntary compliance.	17.90%
3	Stakeholders buy-in	This criterion assesses the likely level of endorsement and buy-in each option pathway is likely to receive from key stakeholders, including RIMs, RSOs, rail equipment suppliers, government bodies, and the public. Support can be influenced by the perceived benefits, the distribution of costs and responsibilities, and the alignment with stakeholders' strategic interests.	19.14%
4	Timeliness	This criterion considers how quickly the benefits of harmonisation can be delivered under each option pathway. It considers the timeline of implementation, the readiness of stakeholders to adapt to changes, and the speed of the processes involved in rolling out national standards.	14.81%
5	De-risking	This criterion focuses on the risk management practices and de-risking approaches possible within each option pathway. It evaluates how well the option pathway mitigates potential risks to all relevant stakeholders through careful and cautious planning, prudent decision-making, and rigorous quality assurance (QA) measures throughout the option pathway implementation process.	13.70%
6	Efficiency	This criterion examines the resource utilisation efficiency of each option, considering the current constraints in the industry. It assesses how well the option pathway maximises the use of available resources, minimises waste, and leverages existing capabilities to achieve harmonisation goals.	16.30%

The MCA process run here assumes that, if all option pathways are implemented and proceed as intended, then significantly the same benefits of rail standards harmonisation are ultimately achieved. As such, what's different and considered in this MCA is implementation-related criteria.

Further, each of the option pathways were assessed against the criteria in Table 14, using the scoring system outlined at Table 15.

Table 15 MCA scoring system

Score	Description
0	Significantly negative
1	Very negative
2	Negative
3	Slightly negative
4	Little negative impact
5	No/negligible impact
6	Little positive impact
7	Slightly positive
8	Positive
9	Very positive
10	Significantly positive

5.4.2 Results

A summary of results of the MCA, using the criteria, weighting, and scoring system outlined in Section 5.4.1, is provided at Table 16. The detailed breakdown of the results and supporting analysis of this MCA is provided at Appendix C.

Table 16 Option MCA scoring summary

Option Pathway	MCA Score	Preference Ranking
1 – Voluntary	4.59	3
2 – Gradualist Mandatory	***6.89***	***1***
3 – Interventionist Mandatory	5.74	2

Based on the scoring for this MCA, Option Pathway 2 (Gradualist Mandatory Pathway) is the Preferred.

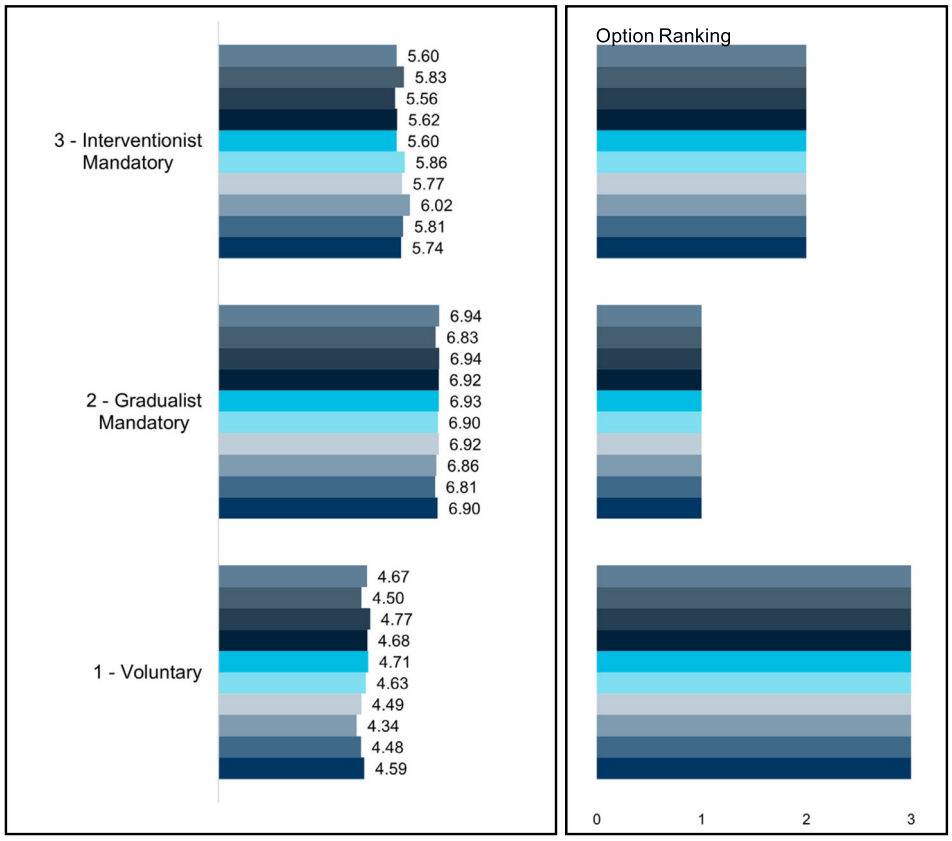
5.4.3 Sensitivity Analysis

To ensure the robustness of Option Pathway 2 (Gradualist Mandatory Pathway) as the Preferred Option Pathway, sensitivity analysis was undertaken against both Pairwise weightings and select criteria scores. This analysis is presented in the subsections below.

Pairwise Weightings

The results of each option pathway, against each Pairwise weighting received (anonymised), are presented in Figure 18. These results show Option Pathway 2 (Gradualist Mandatory Pathway) remains as the Preferred Option Pathway, under each of different Pairwise assessment.

Figure 18 Option pathway score and rank by individual pairwise assessments



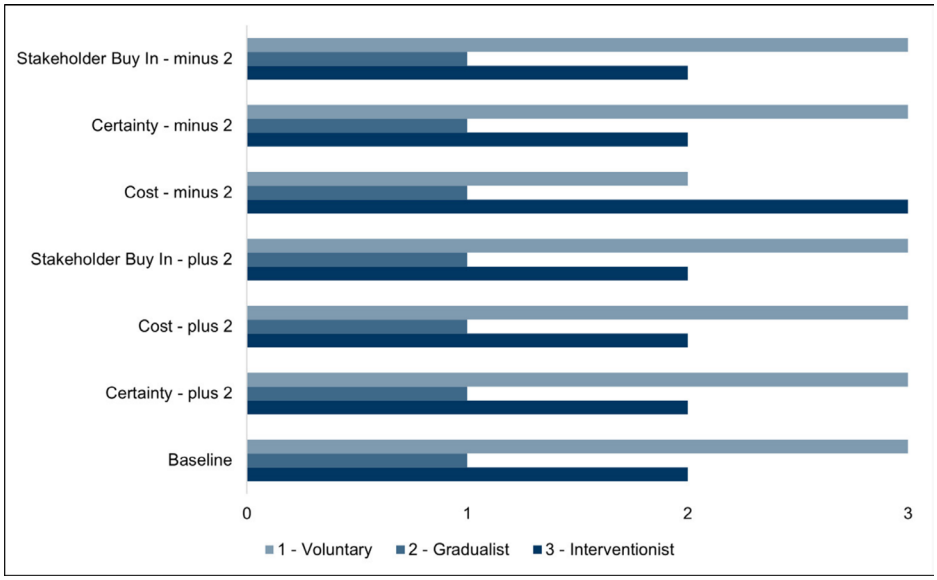
Criteria Scores

To further test the robustness of Option Pathway 2 (Gradualist Mandatory Pathway) as the Preferred Option Pathway, key option scores were adjusted against the below evaluation criteria:

- Certainty (+/- 2).
- Cost (+/- 2).
- Stakeholder Buy In (+/- 2).

The updated rankings are illustrated in Figure 19. These results show Option Pathway 2 (Gradualist Mandatory Pathway) remains as the Preferred Option Pathway under each scenario where the key criteria scores were adjusted. The only ranking change is when Cost is scored lower, Option 1 and 3 swap rankings to 2 and 3 respectively (no change to Option 2 as rank 1)

Figure 19 Option pathway rank by adjusted key criteria scores



6. Key Option Pathway Implementation Considerations

The benefits sought from harmonised standards do not materialise until the standards have been adopted and implemented[271]. As such, implementation considerations form an important part of achieving rail standards harmonisation, for any given option pathway or any possible set of initiatives. In this light and given the relatively strategic and high-level nature of the defined initiatives that inform the preferred and other option pathways, several key implementation considerations are outlined in this Section. They are as follows:

- Capability and Role of RISSB.
- Aligning Australia with International Standards.
- Ensuring the Best Approach for Developing Standards for High Adoption.
- Enforcing Mandatory Harmonisation.
- Alleviating Transition Cost Concerns.
- Independent Regulation and Centralised Governance.
- Maintaining Stakeholder Buy-in.
- Defining a Continued Role for Co-Regulation.
- Dealing with Short-term Non-compliance.
- Managing Continued Infrastructure Differences.
- Dealing with Self-contained Networks.
- Unintended Consequences.

6.1 Capability and Role of RISSB

RISSB's current structure reflects its role in Australia's voluntary standards environment, whereby reliance is the concern of the user, who can assess if a standard meets their organisation's operational environment and risk profile. However, if the policy environment around rail standards harmonisation were to change such as through mandating, then the demands on the standards that RISSB produces may increase substantially, meaning that the capability and role of RISSB, including its standard development processes, would need to be reviewed and likely recast. This is a key driving factor behind the initiative to "undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation", which is apparent in every defined option pathway (see Section 5).

Currently, RISSB relies on a small body of core staff as well as a significant quantity of 'in kind' resources from RIMs and other stakeholders[272]. This is not how analogous organisations are structured in jurisdictions with mandatory standards. For example, the Rail Safety and Standards Board (RSSB) in the UK employs a large proportion of the types of specialists which RISSB would rely on in-kind assistance for, while the European Union Agency for Railways (ERA), which is responsible for TSIs, has approximately 200 in-house staff members[273].

Given that the usefulness of standards is highly dependent on how well they are written and how they relate to a user's needs[274], and that sufficient national standards need to be available to address the key categories of systems,

271 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 40.

272 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 2.

273 European Union Agency for Railways. Standards and Interoperability: A European Perspektive. Presentation Slides, 17 November 2023.

274 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 31.

procedures, and infrastructure involved in progressing to improving interoperability[275], the capability and role of RISSB as the national standard entity is highly important to any option pathway. Without sufficient capability, harmonisation under any option pathway, especially a mandated option pathway, will be compromised.

Further, this consideration of RISSB's capability and role dovetails with the fact that the Government has agreed to "develop a new approach to setting interoperable standards to improve productivity and safety and advise on a national standards framework", under a four-year fully funded NRAP Phase 2 program.[276]

That said, a highly self-driven RISSB that does significant standards prioritisation and development work in-house may risk stakeholder backlash. This is not only because it risks developing standards products that do not meet the needs of diverse stakeholders (see Section 4.3.1), but also because the ability to influence standards was identified as one of the best aspects of being a member of RISSB, in the 2022 RISSB member survey.[277]

Stakeholder Input: Resourcing and Governance

At the Options workshops[278], stakeholders responded to several initiatives with concerns around resourcing and governance. This included resourcing and governance for RISSB, as well as other relevant rail sector entities more broadly. Resourcing was raised as a potential concern for the initiatives to establish a central directory or database for high benefit standards, greater harmonisation-specific stakeholder collaboration forums and technical working groups, and the incentive programs for early harmonised standards adopters. Feedback included ensuring that decision-making is transparent and open, and that detailed plans are provided before an initiative is adopted. Stakeholders emphasised the importance of developing a national strategy, with targets and KPIs to accompany clear governance, accountability, and responsibility.

6.2 Aligning Australia with International Standards

In any process of rail standards harmonisation, benefits can be increased in certain areas[279] if standards are aligned to international standards, such as those from the International Union of Railways (UIC), International Organization for Standardization (ISO), European Standards (EN), and British Standards (BS). This is especially true for rolling stock manufacturing because, to export Australian railway products, Australian producers will need to comply with recognised international standards. Additionally, overseas railway product providers will not necessarily build the latest technology that they have developed to any Australian standard but will comply with the standards of major customers, such as those in the EU, America, or Asia.

In this context, it is important to consider how Australia can align with international standards as part of an implementation option. Here, there are several avenues to be considered in conjunction with the option pathway, including the following:

- Mandatory international standards evaluation by RISSB.
- International expert and knowledge exchange programs.

Mandatory International Standards Evaluation by RISSB

Under this approach, before any new Australian rail standard is developed, RISSB would be legally or institutionally required to evaluate relevant international standards. In the same way as the initiative of "mandatory disclosure of derogation for non-standard projects and system changes" would require RIMs and RSOs to justify non-harmonised standards, this approach would require RISSB to justify non-international standards.

This process would involve the following:

- **Comprehensive Assessment:** RISSB conducts a thorough analysis to determine if an existing international standard can be appropriately applied within the Australian context.
- **Adaptation and Adoption:** If the international standard is deemed appropriate, RISSB would work on adapting it to fit Australia's specific conditions and regulatory framework, ensuring that it addresses local challenges while maintaining international compatibility and benefit.

275 Rail Industry Safety and Standards Board (RISSB). Rail Systems Interoperability Guidelines. 2015. Pg., 15.

276 National Transport Commission (NTC). National Rail Action Plan: Rail Industry Executive Committee. Presentation Slides, 23 August 2023.

277 Phillips Group. Summary of preliminary findings: RISSB Member Research. Phillips Group (for RISSB), 2022.

278 See: Stakeholder Engagement Report (Appendix A).

279 NOTE: While it is often beneficial to align to international standards, in some areas, such as attempting to harmonise legacy operations, it could be counter-productive to force an internationally consistent approach.

– **Stakeholder Consultation:** Continue to engage with industry stakeholders to understand the practical implications of adopting the international standard.

This approach ensures that Australia leverages the best practices from around the world, reduces the duplication of effort in standard development, and promotes a more harmonised rail industry both domestically and internationally. It also directly responds to the barrier of the "Nature of Voluntary National (RISSB) Standards" (See Section 4.2.4), by prioritising functional international standards where feasible, thus fostering a more unified approach to rail safety and operations to the benefit of the domestic rolling stock industry and domestic rolling stock procurement agencies.

While this approach is highly aligned with mandating under option pathway 2 or 3, some version could also be integrated into RISSB's standard development procedures in a voluntary environment.

Furthermore, there may be cases where an existing RISSB standard might be rendered obsolete by a new or updated international standard, which should also be identified above any beyond considering international standards only when a 'new' Australian standard is being developed. Identification and formal consideration of these instances could be a major part of RISSB's ongoing business practice under a mandatory standards regime.

International Expert and Knowledge Exchange Programs

This initiative aims to foster a culture of continuous learning and global best practices within the Australian rail industry. The program's objective would be to facilitate the exchange of knowledge, expertise, and technical skills between Australian rail professionals and their international counterparts. This is achieved through a structured exchange program that allows for short-term assignments or collaborative projects involving experts from countries with advanced rail systems. The method involves creating partnerships with international rail organisations and setting up a framework that allows for the seamless exchange of rail professionals between countries. The program would ensure that participants are exposed to a variety of standards and practices, including those about safety, interoperability, and rolling stock, as well as other identified 'high benefit' standard areas (see Section 5.2.1).

This program would work to enrich the Australian rail industry with greater international perspectives and practices. Participants returning from these exchanges would bring back valuable insights into how international standards are implemented and managed, as well as how they are effective. This would help in breaking down the barriers of a risk-averse culture and path dependency (see Section 4.2) by showcasing the tangible benefits of international standards and their functioning on networks with similar characteristics overseas. That said, without any enforcement or direct mandate and accountability to adopt international standards, it is doubtful as to whether this collaborative approach would be effective in achieving its desired outcomes, at least in isolation.

This approach is highly aligned with the voluntary option pathway 1.

6.3 Ensuring the Best Approach for Developing Standards for High Adoption

Under a voluntary standards regime, national standards must have a high rate of voluntary adoption, to ensure that the scale benefits of harmonisation are realised. Importantly, to achieve this high rate of adoption, it is key that the national standards developed by RISSB are of high quality and have key stakeholder (RIMs and RSOs) buy-in.

In developing national standards that are of high quality, as well as supported by key stakeholders, there are some key approaches and considerations that inform best practice, which could be incorporated into a more fulsome model of national standard development. These include the following:

– **Increased Resourcing and Capability of RISSB:** As noted in Section 6.1, RISSB currently relies on a small body of core staff as well as a significant quantity of 'in kind' resources from RIMs and other stakeholders, as well as the substantial engagement of RISSB personnel for key roles[280]. This is not how analogous organisations are structured internationally, with the EU's ERA, which is responsible for TSIs, having approximately 200 in-house staff members[281]. Therefore, increasing RISSB's direct resourcing and capability to be more in line with analogous organisations internationally, would be one way of working to ensure high standard quality, as well as engaging more extensively with key stakeholders.
– **Direct Adoption of Proven Standards:** Currently, RISSB develops its products, including standards, to be bespoke, Australian products. However, RISSB's approach to standards development could be changed, to focus more on identifying international or network-specific best practices and working to adopt those standards as national standards with only minor revisions, as needed for stakeholder-identified technical reasons. Not only

280 Rail Industry Safety and Standards Board (RISSB). Submission to Senate Rural and Regional Affairs and Transport References Committee into The State of Australia's Rail Industry. 2016. Pg., 2.

281 European Union Agency for Railways. Standards and Interoperability: A European Perspektive. Presentation Slides, 17 November 2023.

would this increase RISSB's quantity of output but would ensure standards are of high quality and more likely to be adopted. This approach also aligns with the overarching ambition of aligning Australia more with international standards, as outlined in Section 6.2.

- **Mandatory Involvement of RIM and RSO Subject Matter Experts (SMEs):** Presently, RISSB standards are developed with voluntary standard development groups. These standard development groups suffer from high rates of attrition, which lead to a relative drop in standard quality as opposed to if these groups retained their SMEs throughout the development process. As identified several times throughout the *Stakeholder Engagement Report* (Appendix A), getting the RIM and RSO SMEs to contribute to standard development is the best way to ensure both standard quality and increase the likelihood of RIMs and RSOs adopting the finished standard product. As such, mandatory involvement in development groups must be considered.

Note that although these above approaches and considerations are important for ensuring high quality and key stakeholder buy in to increase adoption, the outcomes of high-quality standards are key stakeholder buy-in are also important in the successful implementation of a transition to a mandatory standards environment. Because of this, it is recommended that a more complete approach to developing standards with high rates of adoption, be developed as part of the initiative to "undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation". The best approach to developing standards is highly interrelated with the option pathway pursued, and so must be aligned with the broader standards regime and regulatory context.

6.4 Enforcing Mandatory Harmonisation

In implementing some form of regulation to mandate a limited range of specific standards, as under option pathway 2 and 3, there are several considerations around how this mandating works in practice, and who has the role of enforcing the mandate legally.

In the EU, the primary legal basis related to the TSIs, and mandated standards, are the relevant EU Directives. On a secondary level, there are EU Decisions that develop essential and technical requirements more in-depth[282]. As an EU Directive, TSIs must be incorporated by EU countries into their national legislation. As for all EU Directives, if national authorities fail to properly implement EU laws, the European Commission may launch a formal infringement procedure against the country in question. If the issue is still not settled, the Commission may eventually refer the case to the Court of Justice of the European Union. In some cases, the Commission may request the European Court to impose financial sanctions on the Member State concerned[283].

Importantly, the nature of the enforcement mechanisms existing under EU law are vastly different to that which could possibly be instituted in Australia. The key difference being that in the EU, the European Commission punishes nations for non-compliance, while in Australia, a regulatory body within the nation would have to punish individual RIMs and RSOs.

In this context, the central avenue for mandatory standards enforcement is to include mandating and harmonisation-related standard compliance into the existing role of ONRSR, through an amendment to the RSNL. This would involve strengthening the role of ONRSR to ensure RIMs and RSOs adhere to mandatory standards. Importantly, this change would require a legal framework to be implemented that outlines the specific standards to be enforced and defined penalties for non-compliance, as well as associated provisions regarding legal liability related to national standards implementation.

6.5 Alleviating Transition Cost Concerns

Any process of rail standards harmonisation that enforces changes for RIMs and RSOs, without an appropriate response to compensate them, will cause a significant loss in stakeholder buy-in. This loss of stakeholder buy-in could then be enough to cause the process of harmonisation to become unpopular and lose the political and industry support that it needs to be successful over a multi-year transition period.

The first order in compensating RIMs and RSOs during a mandatory transition is alleviating transition cost concerns, such as when RIMs or RSOs must make changes to become compliant. This reality dovetails with "compliance costs and commercial pressures" being a key identified barrier to harmonisation in the current, voluntary regulatory environment (see Section 4.2.6).

282 European Commission. What are the legal basis and the key documents? Directorate-General for Mobility and Transport, N.d. https://transport.ec.europa.eu/transport-modes/rail/ertms/what-are-legal-basis-and-key-documents_en

283 European Commission. Implementing EU law. Directorate-General for Communication, N.d. https://commission.europa.eu/law/application-eu-law/implementing-eu-law_en

Although, as identified in the *Taig Review*, "blank cheques from Government are not a viable solution" to meet the cost of migration towards harmonised standards[284], consideration needs to be given to alleviating transition cost concerns. This consideration can take several forms, including the following, which are not mutually exclusive:

- **Only apply mandatory standards to new systems:** If mandatory standards only apply to new systems, as well as conditionally to renewed or upgraded systems, they will not generate significant costs, as they would not apply to existing systems and would thus not require costly retrospective action. This was a strong consideration of option pathway 2, but not option pathway 3.
- **Establish a fund to compensate the costs of harmonisation:** Any form of mandatory harmonisation will impose costs on RIMs and RSOs, which will impede stakeholder support. Additionally, harmonisation will bring an economic benefit to the nation, as detailed in Section 3 and quantified in Section 7. As such, given the economic benefits available, there is the potential to develop a net positive economic model to compensate the 'losers' in harmonisation and balance inequalities. Funds from the potential gains achievable through reduced non-interoperability and other economic benefits can be reallocated to address RIMs and RSOs that must adapt to new, mandatory standard regimes. Importantly, this idea of "government support for industry in meeting the cost of change to comply with new standards", was an explicit initiative contained within both mandatory standard option pathways 2 and 3.

6.6 Independent Regulation and Centralised Governance

As part of a successful process of rail standards harmonisation, the regulatory and governance regime will need to be well-defined and accountable. This consideration is accounted for as part of the initiative to "undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation".

That said, there are clear lessons to be learned from the EU in this area. Indeed, in the EU, there is a clear pattern of increasing centralisation (see Section 2.3.1), with a strong member-driven organisation (the ERA), supported by a clear governance framework and independent regulators in each jurisdiction; leading the development of TSIs to drive interoperability across jurisdictions.

In terms of governance for the evolution of rail reform in the EU to deliver interoperability, there are several key lessons learned, including the following:

- It is important to have a member-driven organisation (in the EU's case, the ERA) with representatives from each jurisdiction, as well as technical working groups to identify and prioritise subgroups for the setting of TSIs. Cross-jurisdictional standard setting helps to alleviate either political influence, or more typically, mitigates against strong engineering 'empires' that have long-standing ways of working with little incentive to change or align standards across borders.
- It is effective to have a representative regulator in each jurisdiction (who is also a member of the ERA) that has the responsibility for ensuring TSIs are either effectively implemented, or that there is a clear demonstration for any derogation away from the TSI as required.
- Direct engagement from all rail users (i.e., operators and infrastructure owners) in the ERA's TSI development process is vital to their success.

In Australia, given the EU experience, items to consider include the following:

- The degree to which there is sufficient independence of rail regulation and standard setting in each state, and the incentives of each organisation to align. This is especially true given that "minimal incentive to change" is the key identified barrier to harmonisation (see Section 4.2.1).
- Although ONRSR provides national level regulatory and enforcement responsibility for rail safety (like what the ERA does in the EU) and RISSB produces voluntary standards, at a state level, standard setting and regulation is a mixture of activities from entities like TfNSW, State Government Departments in Victoria, South Australia and Western Australia, as well as Queensland Rail and TasRail. As noted above, there are weak incentives to align standards under this regime, which can be mitigated in a collaborative standard-setting environment at a national level.
- It would be beneficial to establish national standard-setting working groups with agreed mandatory and voluntary criteria within an appropriate legislative framework (agreed with the states), to drive through change via an organisation such as RISSB.

284 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 41.

6.7 Maintaining Stakeholder Buy-in

Aside from simply alleviating cost concerns (see Section 6.5), the broader support of RIMs and RSOs is crucial in the development and adoption of rail standards, due to their significant influence on the operational and safety aspects of railway networks. RIMs and RSO's buy-in ensures that the standards are not only technically sound but also practically applicable, reflecting the realities of day-to-day operations. When RIMs and RSOs are actively involved in the standard-setting process, they are more likely to support and implement these standards, leading to a higher rate of adoption. This collaboration also facilitates a more seamless integration of safety, efficiency, and interoperability across different networks.

In this context, mandatory standards pose an inherent risk, given that, as acknowledged in the *Taig Review*, "if standards were to become mandatory RISSB has a very real concern that industry support for the whole process would collapse"[285]. RIMs and RSOs are currently 'masters of their own destiny' under co-regulation and are largely left to run operations that they believe they are best placed to self-regulation within the bounds of the RSNL. This is a situation they view favourably, with "the ability to influence standards" identified as the best aspect of being a member of RISSB, in the 2022 RISSB member survey.[286]

However, RIMs and RSOs also acknowledge that, especially in recent years, rail standards harmonisation has an industry-wide benefit, as outlined in Section 4.1.2 and throughout the Stakeholder Engagement Report (Appendix A). As such, this does not rule out a process of mandating in any way. Instead, it simply highlights that any process of mandating or otherwise curtailing the relatively free reign of RIMs and RSOs must be done with some degree of their buy-in and agreement, ensuring that decision-making is transparent and open, as well as clearly expounding and promoting the benefits of significant regulatory changes.

Stakeholder Input: Supporting Industry Participation

At the Options workshops[287], gaining stakeholder buy-in was raised as central to several initiatives. The active involvement of RIMs and RSOs means that they are more likely to support and implement these standards, leading to a higher rate of adoption. That said, stakeholders also noted that the voluntary nature of the standards regime may result in a continued lack of action, and industry participation needs to be supported through incentive or enforcement mechanisms.

6.8 Defining a Continued Role for Co-Regulation

In any process of mandating national rail standards, as under option pathways 2 and 3, consideration must be given to defining a continued role for co-regulation. The current co-regulatory framework, even though it does not provide sufficient incentives towards standards harmonisation in key areas such as interoperability and rolling stock components (see Section 4.2.1), does have benefits in the Australian rail environment given the diversity of operators and types of operations[288]. Indeed, co-regulation enables ONRSR to tailor the regulatory approach to individual operators or to specific safety issues, as well as enables individual RSOs to tailor and innovate risk management controls to their specific railway operations and risk profiles, given that it is currently not feasible to satisfy the diverse needs of the entire national network with one single set of all-encompassing standards across all networks[289]. This outcome is achieved under section 46 of the RSNL, whereby duty holders are required to both eliminate risks to safety so far as is reasonably practicable and, if it is not reasonably practicable to eliminate risks to safety, to minimise those risks so far as is reasonably practicable[290]. This concept of 'so far as is reasonably practicable' (SFAIRP) empowers RIMs and RSOs is to achieve the best possible safety outcomes, to the extent that is 'reasonably practicable' under the circumstances that are specific to their operations[291].

In this context, it is important when implementing a given option to carve out a continued role for co-regulation, alongside realising the benefits of high benefit standards harmonisation. Here, the avenue to pursue is to ensure that co-regulation remains the governing regulatory structure of Australian rail networks for all standards that are not considered 'high benefit' or a National Priority enough to be mandated, if that is the option pathway pursued. Put simply, if harmonising a particular standard does not yield sufficient interoperability, manufacturing, safety, or other benefit, then it remains the domain of the RIM or RSO under the current co-regulatory framework.

285 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 41.

286 Phillips Group. Summary of preliminary findings: RISSB Member Research. Phillips Group (for RISSB), 2022.

287 See: Stakeholder Engagement Report (Appendix A).

288 Office of the National Rail Safety Regulator (ONRSR). The ONRSR Way: Regulating Rail Safety. ONRSR, 2021. Pg., 12.

289 Palazzi Rail. National Framework for Rail Interoperability (NFRI): Overview. Palazzi Rail (for RISSB), 2022. Pg., 8.

290 Office of the National Rail Safety Regulator (ONRSR). ONRSR Guideline: Meaning of duty to ensure safety so far as is reasonably practicable. ONRSR, 2021. Pg., 4.

291 Office of the National Rail Safety Regulator (ONRSR). ONRSR Guideline: Meaning of duty to ensure safety so far as is reasonably practicable. ONRSR, 2021. Pg., 4.

Before starting to draft new, national, and harmonised standards, there needs to be an assessment within RISSB or other relevant entity of which operational processes and products are not required to be standardised. The target in Australia should not be all-encompassing harmonisation across all standards but should focus only on the areas of standards under which there is clear and demonstrable economic benefit.[292]

Interestingly, this is the same broad approach currently in place in the EU. Indeed, in the EU, the implementation of TSIs does not mean that all aspects of the EU rail system have been harmonised, but rather only those that are linked to interoperability[293]. Voluntary Notified National Technical Rules (NNTRs), which are at the Member State and not EU-level, remain a key complementary element to the EU's TSIs and rail standards regime, such as where special provisions or technical use cases are needed.

6.9 Dealing with Short-term Non-compliance

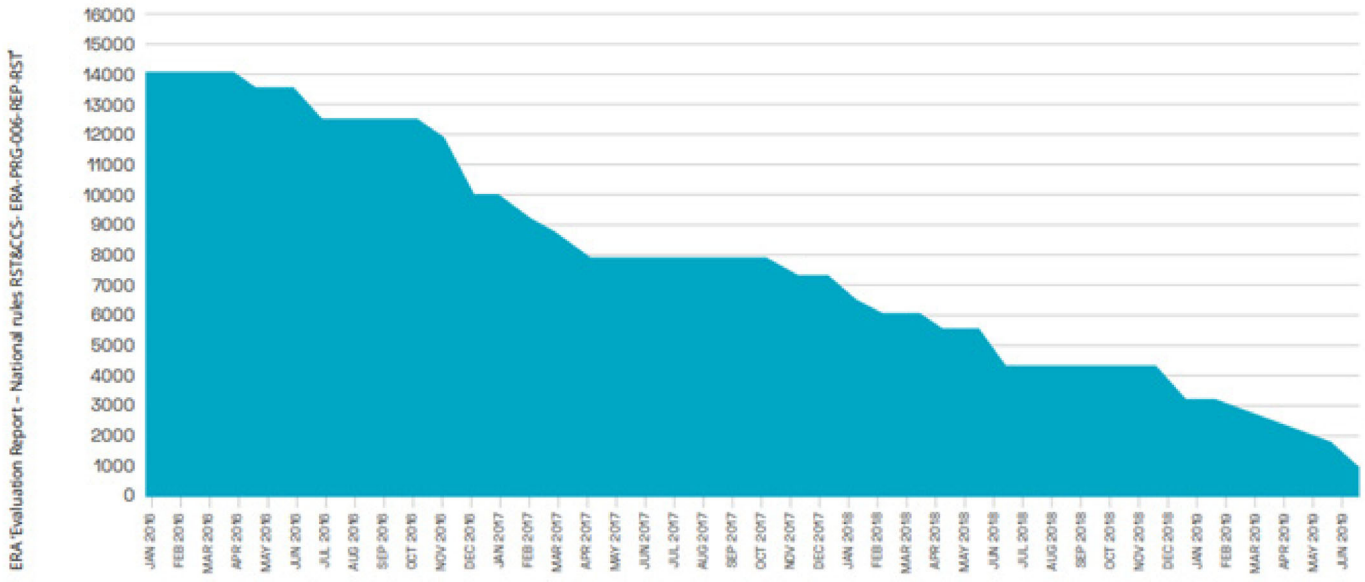
An obvious difficulty in any transition to a new rail standards regime is that rapid changes could render the current, compliant, operations of both RIMs and RSOs non-compliant, unless impractically rapid and costly changes are made. Additionally, a rapid transition could also lead to network disruptions that would be counterproductive to rail's value proposition and to achieving the identified benefits of standards harmonisation. These considerations are especially pertinent for option pathway 3, which focusses on interventionist mandating.

As a result of the above, to foster widespread agreement on harmonised solutions, it's essential to create a framework that allows RIMs and RSOs to continue their existing methods, which don't align with the new national standards, potentially over an extended period, as part of a staged introduction of interoperability. This challenge has been significant in the effort to harmonise standards with the TSIs across the EU[294].

To deal with short-term non-compliance in the EU, the bloc has instituted Notified National Technical Rules (NNTRs), which are an essential tool for the management of national legacy systems.[295] Indeed, in the EU, the non-application of TSI requirements, and their substitution with NNTRs, remains a common practice where technically necessary, despite the TSIs remaining mandatory[296]. This approach mirrors the "mandatory disclosure of derogation for non-standard projects and system changes" initiative included in both option pathway 2 and 3.

With this approach, the transition to universal TSIs has been gradual, even after the TSIs were formally mandated. This is visible from the number of NNTR derogation requests addressed to the European Commission, which have significantly decreased in some areas (with significant variation across Member States), as outlined in Figure 20.

Figure 20 Evolution of National Rules for vehicle authorisation in addition to TSIs



292 International Union of Railways (UIC). Railway Standardisation Strategy: Europe. UIC, 2016. Pg., 13, 17.

293 European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 21.

294 Taig, Tony. Review of the Rail Industry Safety and Standards Board and its MOU with the Governments. TTAC (for TfNSW), 2012. Pg., 24.

295 UNIFE. The Technical Framework of the European Railway Sector. UNIFE, 2021. Pg., 6.

296 European Union Agency for Railways. Report on Railway Safety and Interoperability in the EU. ERA, 2022.

In Australia, a legal mechanism for enabling short-term non-compliance could be based on ONRSR's existing Improvement Notice provision.[297]

6.10 Managing Continued Infrastructure Differences

As outlined in Section 4.2.5, differences across networks in physical rail infrastructure such as kinematic envelopes, tunnel and platform heights, and overhead electricity, provide significant barriers to harmonisation[298]. This means that standards are necessary, but not sufficient, for interoperability and benefit realisation. Other challenges, including disparate and incompatible infrastructure, will remain. While this is not to discount the benefits that can be achieved from standards harmonisation, it reflects the fact that any harmonisation implementation pathway will have to mitigate inherent and significant differences associated with long-life infrastructure assets.

In the EU, infrastructure differences are being harmonised through the specified 'Infrastructure TSI', which covers both the infrastructure structural subsystem (i.e., line layout, track parameters, platforms, and load resistance) as well as the maintenance functional subsystem for infrastructure (i.e., train washing plants, water restocking, refuelling, toilet discharge facilities, and electrical shore supplies) across the bloc[299]. Until such a time that infrastructure harmonisation occurs, which is a long-term ambition given the long life of rail infrastructure assets, associated implementation regulation[300] outlines specific provisions for the practical phase out or integration of legacy infrastructure into an EU-wide network, on infrastructure type-by-type basis.

6.11 Dealing with Self-contained Networks

In any process to harmonise Australian rail standards, it is crucial to consider the unique characteristics and operational requirements of self-contained rail networks, such as the TasRail Tasmanian freight network on the privately owned and operated Pilbara iron ore networks (see Figure 4 in Section 2.1.3). This is because, while the adoption of national standards has interoperability benefits, self-contained rail networks that operate independently and do not interface with other rail systems, so may find little to no benefit in conforming to broader national interoperability standards. The imposition of such standards on these isolated, standalone networks could lead to substantial costs without delivering proportional value or economic benefit[301].

However, while there is little to no benefit to applying national standards related to interoperability to self-contained networks, it is important to note that component manufacturing standards, which largely determine the economies of scale for supplier, are still equally as relevant here as they are for non-self-contained networks.

As a result of the above, a unique approach to harmonisation is needed for Australia's self-contained networks, which is responsive to their needs and purpose. For example, standards related to interoperability are irrelevant to self-contained networks, and so should not be mandated for them, instead remaining the preserve of the current co-regulatory regime in the manner outlined in Section 6.8.

6.12 Unintended Consequences

In any policy implementation process, it is important to consider the potential for unintended consequences. Unintended consequences in the context of rail standards harmonisation could range from minor disruptions in service to significant safety hazards, financial losses, or even systemic network failures.

An example of a potential unintended consequence of standards harmonisation is that, under a mandatory approach with grandfathering, the additional costs to achieve mandatory standards compliance may reduce the economic case for equipment replacement, potentially resulting in prolongation of service life, even in the face of potentially higher operational costs. A radically different example of an unintended consequence associated with standards harmonisation is that there could be a negative impact to local manufacturing if standards are aligned to international standards, as there is less potential for domestic product specialisation and lower barriers to overseas competitors entering the Australian market. A further example of an unintended consequence is that harmonisation to a complex, costly, standard could increase the cost of associated rail infrastructure and other rail initiatives; increasing the costs passed on to RSOs and thus impeding rail's modal competitiveness.

297 ONRSR. N.d., Notices. https://www.onrsr.com.au/operator-essentials/audits-inspections-compliance-measures/notices.

298 Nine Squared. Benefits of Harmonised Rollingstock Components. Nine Squared (for NTC), 2022. Pg., 19.

299 European Union Agency for Railways (ERA). Infrastructure TSI. N.d., https://www.era.europa.eu/domains/technical-specifications-interoperability/infrastructure-tsi_en.

300 "Commission Implementing Regulation (EU) 2019/776 of 16 May 2019", and "Commission Implementing Regulation (EU) 2023/1694 of 10 August 2023".

301 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 19.

The most effective strategy for dealing with unintended consequences is the adoption of a phased implementation approach. This allows for the gradual integration of new, national or international standards, providing an opportunity to monitor outcomes and adjust procedures as necessary. During each phase, feedback loops should be established to gather data and insights from all levels of operation. This information can then be used to refine the harmonisation process, ensuring that any negative impacts are identified early and addressed promptly. Given that any process of standards harmonisation will inherently be a multi-year process, rail standards harmonisation naturally lends itself to a phased approach.

Additionally, stakeholders need to be brought into the harmonisation process, so that the industry can collectively identify potential issues as they emerge and before they escalate. Current RIMs and RSOs hold a vast body of knowledge and expertise on rail standards and their application in Australia, meaning any de-risked pathway for standards harmonisation must ensure their buy-in and continued involvement.

7. Economic Analysis of Standards Harmonisation

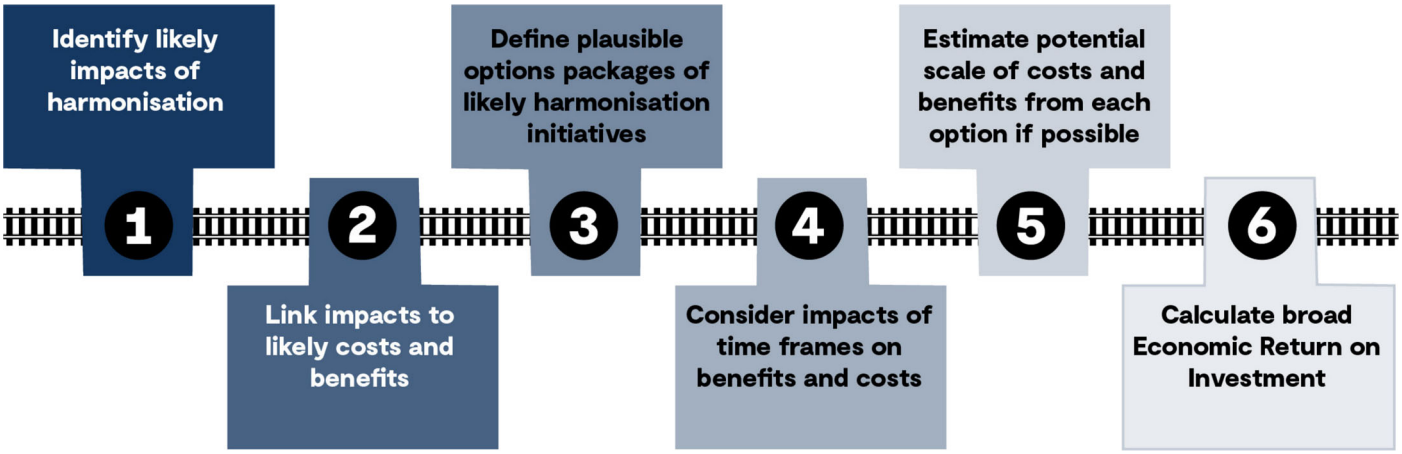
Quantifying the economic benefits and costs of harmonisation poses a unique challenge, which has been the conclusion of various other studies in the area[302]. The benefits of harmonisation can be measured only very partially in technical terms[303], and cost estimates are impossible to determine for specific changes at this time, given that the harmonisation initiatives and option pathways are defined at the strategic 'standard group' level, not for specific standards. Cost information for key values is also, often, commercial-in-confidence and unavailable.

Despite these challenges, this *Report* has developed a fit-for-purpose economic approach quantifying the benefits and costs for harmonising standards, with a focus on interoperability and manufacturing purposes, including the facilitate the transition to net zero. It is outlined in the subsections below, along with key conclusions.

7.1 Methodology and Approach

There are numerous benefits and costs associated with harmonisation. The study adopted a cost-benefit analysis (CBA) approach to the greatest extent possible while uncertainty remains over how much harmonisation may occur and over what timeframe. The steps in the analysis are shown in Figure 21.

Figure 21 Steps in the economic analysis



7.2 Impacts of Harmonisation

At a headline level, the negative impacts of harmonisation include:

- The cost of developing harmonisation standards
- More training in the short-term required
- More rapid equipment replacement, depending on the adoption timeframe allowed for and any grandfathering
- More rail maintenance due to a switch to rail use.

Harmonisation will improve interoperability, with benefits both leading to increased interoperability and resulting from it. These include:

- Less duplication in training, equipment, type approvals and manufacturing types
- Fewer barriers to entry into the sector
- Less remarshalling
- Improved safety

302 Nine Squared. Estimating the value of RISSB. Nine Squared (for RISSB), 2022. Pg., 30.

303 Rail Industry Safety and Standards Board (RISSB). Rail Systems Interoperability Guidelines. 2015. Pg., 24.

– More efficient rolling stock use
– A greater incentive to switch from road to rail freight.

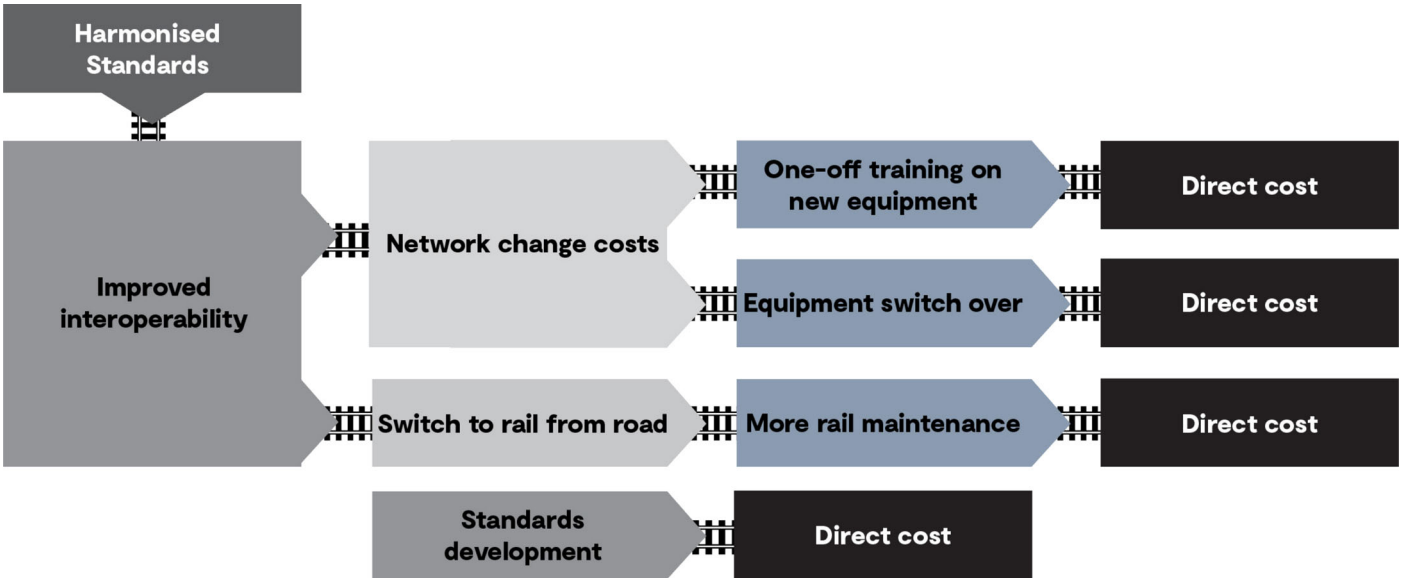
7.3 Costs and Benefits of Harmonisation

Impacts are not the same as benefits or costs. Benefits and costs are directly attributable to people. We identified five categories of benefits and one category of costs associated with harmonisation.

Costs were all direct financial impacts of implementing the changes[304], and included:

– The one-off financial cost of developing harmonisation standards
– The one-off cost of training on new standards and equipment for those in the workforce at harmonisation (noting all new training would be on the new equipment and systems so the cost of ongoing training would be no more than it is today for new recruits)
– The one-off cost of new equipment – communications equipment for jurisdictions not using the current systems; the cost of signalling changes and the like (the latter remains uncosted in this analysis). All future equipment after harmonisation would be replaced with the standardised equipment at no greater cost than today
– The ongoing cost of extra rail maintenance because of a more efficient rail system encouraging a switch to rail from road freight transport.

Figure 22 The costs of harmonisation



There are many benefits to harmonisation. These include:

– Direct cost savings within the rail sector through the following:
  • Reduced duplication:
    – Cheaper rolling stock manufacturing due to a smaller number of types to manufacture[305]
    – Fewer type approvals required
    – Less duplicate equipment required on trains such as radio systems
    – Less training on multiple systems means more labour mobility and consequently fewer staff shortages, leading to a more efficient system and cost savings
  • Lower barriers to entry leading to further cost savings in manufacturing as fewer types and more standardisation encourages new entries to the rolling stock manufacturing market
  • More efficient use of rolling stock because of interoperability, with less downtime for assets and more options for end-of-life use of assets and components

304 NOTE: There would also be indirect costs incurred across the component manufacturing supply chain if a new, harmonised, standard was implemented, because of some combination of new: designs, manufacturing processes, tooling, skills/training, and testing costs. However, given that this economic assessment does not presuppose a specific set of specific standards, this value is not quantified here.

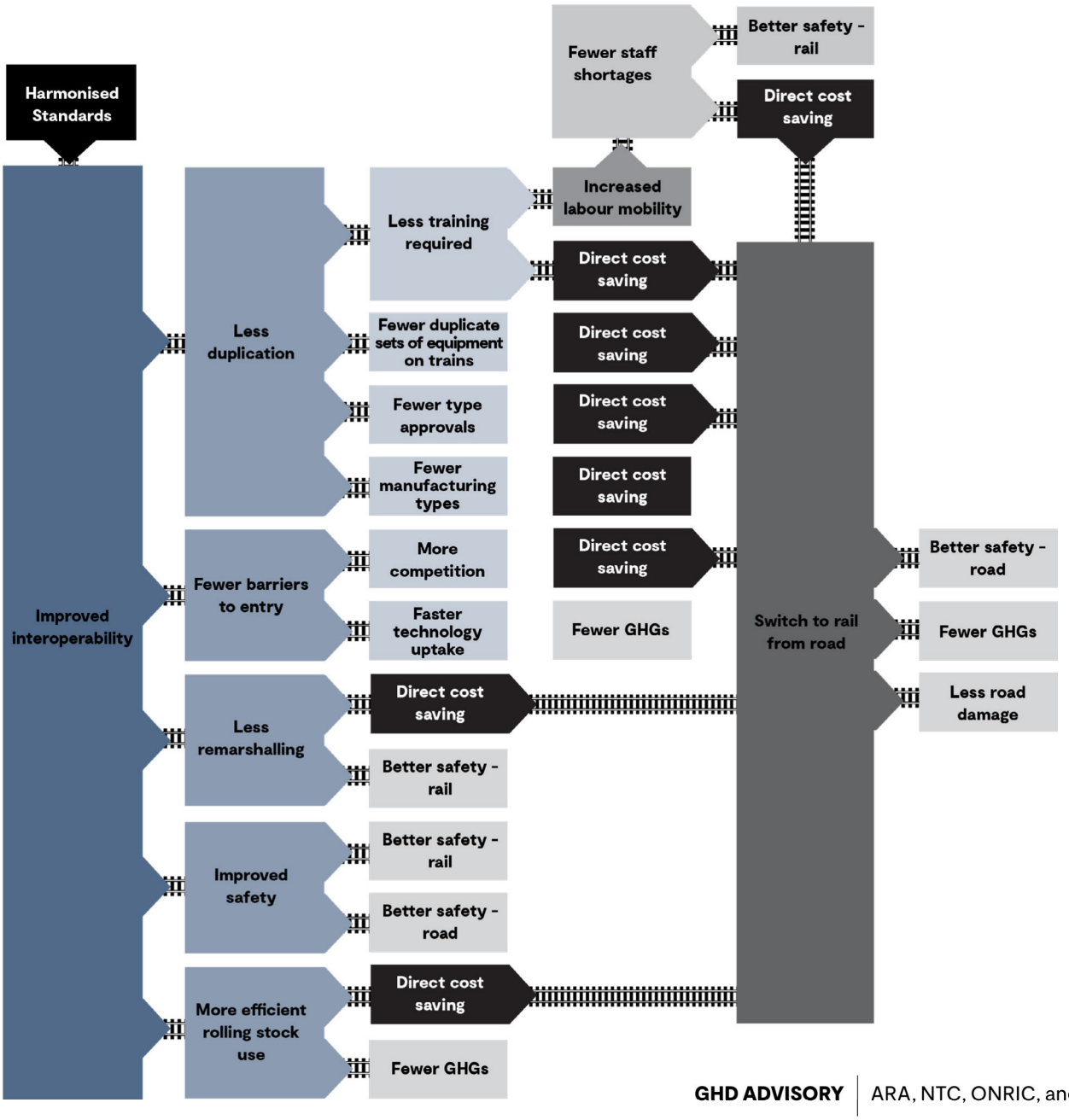
305 NOTE: This said, in a gradualist scenario, older standards will still need to be supported as existing assets age.

- A reduced requirement for training on multiple systems leading to less time spent on training
- The resultant need for less remarshalling leading to fewer staff required for remarshalling
- A switch to more rail use as it becomes more attractive leading to less road damage and consequently lower cost to state and federal taxpayers for road repair

– Safety – fewer fatalities and injuries through:
  - A switch to more rail use leading to fewer road deaths and injuries
  - The resultant need for less remarshalling reducing the risk of accidents
  - Improved safety from reduced sets of rules:
    – Fewer different rules reduce confusion for drivers, resulting in fewer errors and fewer *rail* injuries and fatalities
    – Fewer different rules reduce confusion for drivers, resulting in fewer errors and fewer *road* injuries and fatalities
  - Increased labour mobility across the country leading to fewer staff shortages leading to safer outcomes

– Reduced social cost of carbon emissions through:
  - A switch to more rail use from road use
  - A more efficient use of rolling stock
  - Faster innovation and technology uptake due to more competitive market from fewer types.

Figure 23 The benefits of harmonisation



7.4 Plausible Scenarios of Harmonisation

Discussions with stakeholders indicated strong support for a relatively broad package of harmonisation standards. The main question that remains is whether the estimated benefits and costs in the model are sufficiently balanced, even though we developed estimates in a way that is likely to underestimate benefits and overestimate costs. We therefore developed a Low Benefit / High Cost Scenario (Low Scenario), in which the benefits stream is broadly assumed to be only 50% that in the Base Scenario (noting again that we believe the Base Scenario to be modest in its benefits estimation) and that costs are 125% of those estimated in the Base Scenario. In a separate High Benefit / Low Cost Scenario (High Scenario), we broadly assume benefits are 125% of those estimated in the Base Case, and that costs are only 50% of those in the Base Case.[306]

Table 17 Three Scenarios presented in the analysis

Scenario / Assumptions	Base Scenario	High Benefit /Low Cost Scenario	Low Benefit /High Cost Scenario
Benefits	100% of modelled estimates	125% of modelled estimates	*50% of modelled estimates*
Costs	100% of modelled estimates	50% of modelled estimates	*125% of modelled estimates*
Exception – Rail maintenance costs	*100% of modelled estimates*	*125% of modelled estimates because rail maintenance costs linked to mode shift*	*50% of modelled estimates because rail maintenance costs linked to mode shift*
Exception – Harmonisation standards development	*100% of modelled estimates*	*50% of modelled estimates*	*200% of modelled estimates*

In other words, the analysis assumes a full harmonisation process, but that the scale of benefits and costs vary.

7.5 Impact of Varying Timeframes for Implementation

A further factor to be determined is what an appropriate implementation timeframe may be for harmonisation. If a longer period is set (say, 25 years), then many of the costs associated with the change would be avoided because over that timeframe, most equipment is likely to need replacing anyway[307], and so could adopt the new standards at no marginal cost to what would otherwise need to be spent.

But there are negatives to this approach too. A slow adoption process means the many benefits of harmonisation will take much longer to materialise.

Based on discussions on timeframes and packages of harmonisation that are most likely, the assumption in this analysis is that there is a 10-year timeframe for harmonising standards (with costs for developing those standards incurred over the 10 years), and a further 15-year grandfathering period before all the changes implied by harmonisation must be implemented.

The assumption is that all costs other than standard development are spread across the 25-year timeframe equally (even though in fact costs in the first few years would likely be small and consist only of setting the standards). In other words, costs are likely over-estimated in net present value terms.

We further assume that none of the benefits of the harmonisation begin to accrue until Year 26 even though benefits would, in reality, likely begin to be realised as harmonised systems began to be rolled out through natural replacement processes throughout Years 11 to 25. This assumption also allows for the exclusion of some major costs that may be associated with harmonisation, such as a unified signalling system, as the 25-year timeframe means a large proportion of signalling systems are likely to need replacing anyway during that time and would be replaced with systems that comply with a harmonised set of standards, thus adding no extra cost to the programme.

306 The one exception to these assumptions is impacts related to the switch from road to rail.

307 NOTE: This is accurate even for some fixed infrastructure (such as signaling), which is typically much older than 25 years. This is because signaling (as for many rail technologies) is likely to undergo a substantial transformation in coming decades as the industry moves towards modern technologies, as outlined in Section 4.1.4.

7.6 Potential Scale of Costs and Benefits

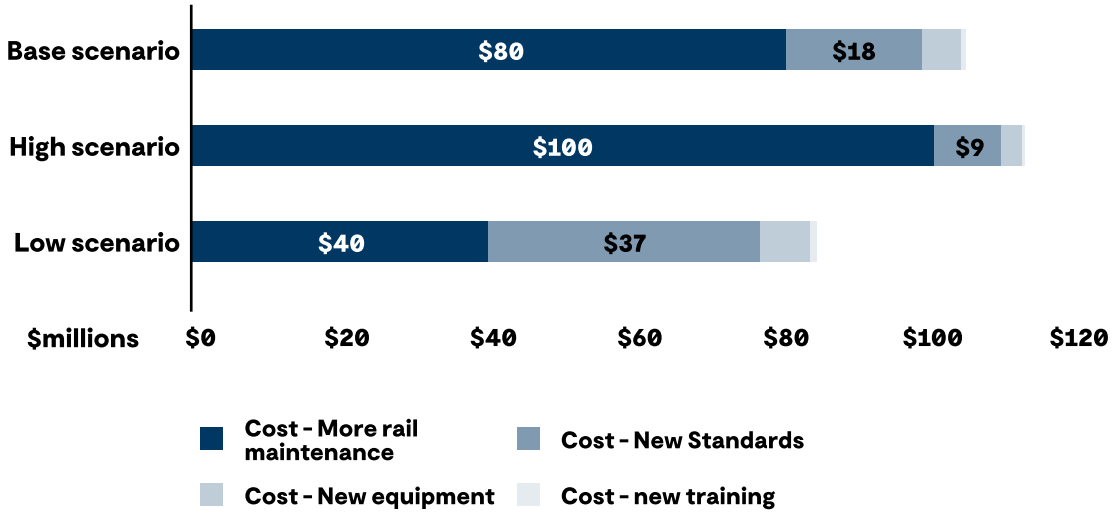
The analysis included building a model and sourcing appropriate data to populate it to allow for a defensible estimation of the benefits and costs. Sources of data were many and varied. Sources are typically included in the model spreadsheet to demonstrate what data was available and are not all repeated here. Where estimates or actual data was not available, we made assumptions, erring on the side of assuming relatively low benefits.

By assuming a 25-year implementation period, we avoid some of the challenges involved in estimating costs that would otherwise be incurred if, for example, new signalling systems had to be implemented over a short timeframe. It is likely that most large-scale investments required for harmonisation would need to occur anyway over the next 25 years. Therefore, it is appropriate to assume no further costs from these systems as they would have to be replaced with either a harmonised or non-harmonised system in the next 25 years anyway.

By far the biggest contributor to costs is likely to be additional maintenance costs associated with higher volumes of traffic on the rail network because of better efficiencies in rail from harmonisation encouraging traffic off the road and onto rail.

We have assumed growth in maintenance costs on rail in line with the assumed increase in volumes carried on rail. This does not allow for the reduced wear and tear on the rail network of more efficiently used rolling stock under a harmonised system, or from the fact that some replacement costs for rail are linked to time in service being exposed to the elements as much as they are to increased traffic. In other words, the increase in costs associated with a switch to more rail freight is likely overestimated.

Figure 24 Indicative contributions to costs of harmonisation by Scenario



It is also important to note that in the High Scenario, which assumes high benefits and low costs, the total cost stream still rises. This is because this scenario assumes a higher mode shift from road to rail. This creates a big increase in rail maintenance costs that kicks in once the road switch begins to materialise. Conversely, total costs fall in the Low Scenario because the shift from road to rail is so much lower.

On the benefits side, the largest single benefit that flows from harmonisation is estimated to be from **manufacturing cost savings** from fewer types leading to more scale in type manufacturing runs, including componentry. Another major benefit comes through **more efficient use of rolling stock**. Although the Base Scenario assumes only a 2% improvement in rail efficiency because of more harmonisation allowing the more efficient use of rolling stock, this is enough to generate a benefit of almost $500 million in net present value terms in the Base Scenario.

The third major benefit stream comes from a **reduced road maintenance burden** due to more freight shifting to rail from road transport. Federal, state and local governments spend around $38 billion a year on road maintenance[308]. Ignoring local government spending (which involves local roads that are still likely to be heavily used by trucks), and based on available data, assuming only 25% of state and federal road spending is on maintenance and repair, an estimated $8 billion is spent on road maintenance each year across Australia. More than 99% of wear and tear is truck-related, given the massive weights carried by trucks. Even a small percentage decrease in highway and arterial truck movements because of a more efficient rail network encouraging a switch, yields annual savings in the hundreds of millions of dollars.

308 BITRE Yearbook 2021/22.

This analysis conservatively estimates in the Base Scenario that for every 1% improvement in rail efficiency, only 0.5% of interstate road freight moves to rail. The Low Scenario assumes the switch is just 0.25% and the High Scenario assumes 0.625%. Further benefits (not estimated here) could accrue if fewer trucks on the road lead to less congestion. This could also reduce road expenditure further for state and federal governments.

The full results of the analysis are presented in Figure 25 and Table 18.

Figure 25 Contributors to benefits of harmonisation

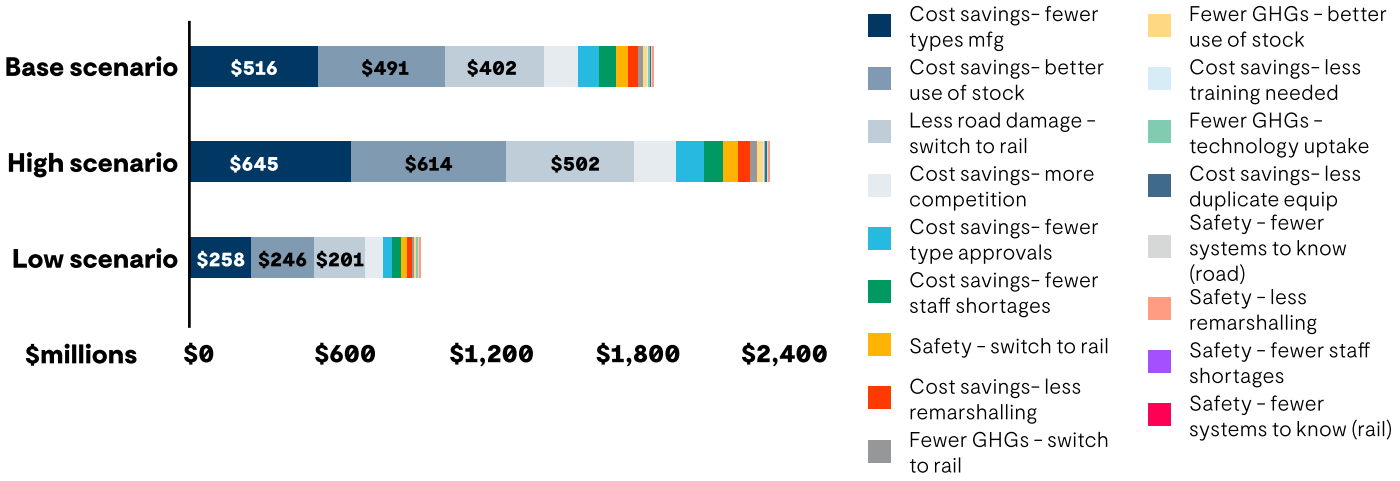


Table 18 Contributors to benefits of harmonisation

Benefit Area	$M (Base)	$M (High)	$M (Low)
Cost savings – fewer types mfg	$515.8	$644.72	$257.89
Cost savings – better use of stock	$491.5	$614.33	$245.73
Less road damage – switch to rail	$401.5	$501.88	$200.75
Cost savings – more competition	$128.9	$161.18	$64.47
Cost savings – fewer type approvals	$85.7	$107.11	$42.84
Cost savings – fewer staff shortages	$61.4	$76.79	$30.72
Safety – switch to rail	$45.1	$56.34	$22.54
Cost savings – less remarshalling	$42.6	$53.22	$21.29
Fewer GHGs – switch to rail	$18.2	$22.71	$9.08
Fewer GHGs – better use of stock	$15.9	$19.85	$7.94
Cost savings – less training needed	$6.0	$7.54	$3.02
Fewer GHGs – technology uptake	$4.2	$5.19	$2.08
Cost savings – less duplicate equip	$2.8	$3.54	$1.41
Safety – fewer systems to know (road)	$2.5	$3.19	$1.27
Safety – less remarshalling	$1.7	$2.12	$0.85
Safety – fewer staff shortages	$0.8	$1.06	$0.42
Safety – fewer systems to know (rail)	$0.8	$1.06	$0.42

In Table 18, the cost savings from "cost savings – fewer types mfg [fewer component manufacturing types]" and "cost savings - more competition" are those benefits in the economic model that relate directly to component standards harmonisation. As such, the sum net benefits of component standards harmonisation are $805.9M, $644.7M, and $322.4M in high, base, and low scenarios, respectively. This is also noting the qualitative benefits of component standards harmonisation, discussed elsewhere in the report (such as Section 3), which are not directly quantified given the level of detail of the analysis (i.e., not selecting a specific set of standards to harmonise). These values are also provided, noting the very conservative assumptions of the model for standards harmonisation; principally the assumption that no benefits accrue until after 25 years, which is very conservative for component manufacturing as opposed to interoperability for example, as benefits would likely begin to accrue far earlier.[309]

7.7 Broad Economic Return on Investment

This analysis has taken an especially conservative approach to estimating the net present value of benefits (i.e. has likely underestimated benefits) and a more balanced approach to estimating costs (i.e. may have overestimated costs) to present a defensible view of the net benefits of harmonisation.

As already highlighted, while we present a Base Case, we also developed two further scenarios – a Low Scenario with higher cost estimates and lower benefit estimates, and a High Scenario with higher benefits and lower cost estimates. We have chosen to present all benefits and costs that could be quantified in this draft report, as if all the proposed harmonisation standards proceed. By adopting a long implementation timeframe (25 years), we avoid the major challenge of trying to price the cost of more rapid signalling and other system replacements because most major systems will need to be replaced in the next 25 years regardless of harmonisation.

But to avoid over-estimating the benefits, we also assume that no benefits start accruing until all the changes are implemented (i.e. Year 26). This is unrealistic but provides a high level of confidence that the very significant benefits of harmonisation are not overestimated.

However, the preferred option of implementing the harmonisation standards with a significant grandfathering period means these assumptions are highly conservative. These assumptions give confidence in the credibility of the estimated benefits, costs, and net present value presented in this report.

Figure 26 Net present value of harmonisation programme

Summary	Base Scenario	High Scenario	Low Scenario
Net present value	**$1,721**	**$2,170**	**$829**
Benefits in $m	**$1,825**	**$2,282**	**$913**
Direct cost savings	$1335	$1,668	$667
Less road damage	$402	$502	$201
Better safety - road	$48	$60	$24
Fewer GHGs	$38	$48	$19
Better safety - rail	$3	$4	$2
Costs in $m	**$104**	**$112**	**$84**

In the **Base Scenario**, net benefits of the full harmonisation programme are $1.7 billion in net present value terms, consisting of $1.8 billion in benefits and $104 million in costs.

309 NOTE: Given that this economic assessment does not presuppose a specific set of specific standards, this cost value of standards harmonisation is not quantified. However, this is acknowledging that there would be indirect costs incurred across the component manufacturing supply chain if a new, harmonised, standard was implemented, because of some combination of new: designs, manufacturing processes, tooling, skills/training, and testing costs.

Also worth noting is that around 22% of the benefits accrue to state and federal governments outside of the rail sector (less road damage, $402 million net present value terms) and to road users through fewer deaths and injuries involving trucks (over $48 million by a very conservative estimate).

The **High Scenario** results in net benefits of the full harmonisation programme of $2.2 billion in net present value terms, consisting of $2.3 billion in benefits and $112 million in costs.

The **Low Scenario** results in net benefits of the full harmonisation programme of $0.8 billion in net present value terms, consisting of $0.9 billion in benefits and $84 million in costs.

As explained in a previous section, costs rise even in the High Scenario because the largest share of costs are linked to the rail maintenance costs incurred by a switch to rail from road freight. Conversely, the Low Scenario sees lower costs because the lower share of freight switching to rail induces less rail maintenance costs.

7.7.1 State-level benefits

It is a challenge to identify how each of these benefits might disaggregate across the states. For instance, direct cost savings at the local level are going to be a function of which systems are chosen through the harmonisation process, or where rolling stock is typically purchased and the efficiency benefits that may be gained at the state level from harmonisation.

However, one category where an estimate of state and federal / commonwealth level savings can be reasonably estimated is the direct savings from less road damage. We can divide up the road damage savings based on:

- State and federal level spending on roading.
- The share of road damage caused by heavy vehicles.
- The same conservative estimates of the share of road spend that is likely on repairs and maintenance used in the headline estimates.
- The estimated impact of greater efficiency in the rail system due to harmonisation as it switches freight from road to rail.

Table 19 Estimated road damage cost savings by state and federal/commonwealth funder

Road damage cost savings	Base Scenario	High Scenario	Low Scenario
Net present value in $m			
NSW	$80	$100	$40
VIC	$106	$133	$53
QLD	$57	$71	$28
SA	$16	$21	$8
WA	$27	$34	$13
TAS	$6	$7	$3
NT	$4	$5	$2
ACT	$3	$4	$1
Federal/Commonwealth	$102	$127	$51
TOTAL	**$402**	**$502**	**$201**

The biggest savings are expected to be in Victoria, where savings in the Base Scenario would amount to $106 million over the analysis period in net present value terms. In cashflow terms, the savings would be around $59 million a year, but a relatively high discount rate of 7% and the assumption that no benefits begin to accrue until the harmonisation process is complete in 25 years leads to a much smaller benefit value in net present terms.

The federal government is the next biggest direct funder of roads and is expected to save $102 million in net present value terms, followed by New South Wales.

Figures are also shown for the High and Low scenarios.

7.7.2 Caveats highlighting defensibility of the estimates

The model assumptions are especially pessimistic on the benefits side, and relatively pessimistic on the cost side, too, which provides confidence that the programme net present value is not over-estimated. We note the following on the **benefits** side:

- The analysis **allows for no growth in the freight task** for road or rail over the 40-year analysis period. This means it may well underestimate the potential to switch more road freight to rail and therefore the net benefits.
- A **real discount rate of 7% is used**, which is recommended by the Department of Prime Minister and Cabinet (DPMC), but which is relatively high.
- We **assume no benefits begin to accrue before the entire harmonisation process is complete** in Year 26 although many of the changes would be introduced incrementally through that period and benefits would realistically develop before Year 26.
- We **use the DPMC value of a statistical life** saved through improved safety throughout. This much lower estimate than the Australian Transport Assessment and Planning estimate means road-safety benefits may be underestimated by over $120 million in net present value terms.
- We assume a particularly **small amount of employee time** is spent on duplicate training (having to learn multiple systems).
- Only allow **a 20% cost saving for fewer manufacturing types**, whereas some studies suggest a much higher saving (circa 30%). A more generous assumption would yield $258 million more in net present value savings.
- A v**ery small reduction in non-suicide train-related deaths and injuries** from all safety improvements, of only a 1.2% reduction in train-related incident injuries and deaths is assumed from harmonisation.
- We assume that a 1% improvement in the efficiency of the rail system leads to a just a 0.5% switch from road to rail on distances over 500 km in length (i.e. **price elasticity of 0.5**), supported by international research.
- Only **25% of road spending by federal and state governments is assumed to be spent on road maintenance** on arterials and highways. In reality this is likely to be higher, meaning greater road damage savings from the switch to rail from road.

It is not practical to include all assumptions and calculations in this report. However, Table 20 lists some of the key assumptions and the scale of the benefit or cost that rely on these assumptions. This provides the reader with some sense of the materiality of the impact.[310]

310 NOTE: Given the nature of this economic assessment, the final values and quantitative conclusions of this Report are highly dependent on these assumptions listed here, which are in turn open to further review and refinement.

Table 20 Key economic analysis assumptions and scale of impact

Number	Benefits assumption	Assumption	Annual benefit scale
1	Improvement in rail network efficiency from labour mobility reducing staff shortages	0.3%	$34.2
2	Percentage reduction in rail injuries and deaths from improved staffing	0.3%	$0.5
3	Share of time spent learning multiple sets of standards (20 hours a year, 2 networks average)	1.1%	$3.4
4	Assumed cost per radio communications system	$15,000	$1.6
5	Average life of communications system in years	10	
6	Assumed share of annual rolling stock spending on new mfg rather than repair	50.0%	$287.2
7	Further reduction in cost from increased competition	5.0%	$71.8
8	Likely reduction in GHGs from faster tech uptake	2.0%	$8.8
9	Reduction in marshalling activity due to harmonisation	33.3%	$23.7
10	Percentage reduction in rail injuries and deaths from less marshalling	0.6%	$0.9
11	Percentage reduction in rail injuries and deaths from less train engineer error	0.3%	$0.5
12	Percentage reduction in road injuries and deaths from less train engineer error	0.9%	$1.4
13	Improvement in rail network efficiency from more efficient use of rolling stock	2.0%	$273.7
14	Likely reduction in GHGs from more backfilling	2.0%	$8.8
15	Assumed relationship betwwen switch from road to rail freight and improvement in rail efficiency	50.0%	$258.8

Number	Cost assumption	Assumption	Annual cost scale
16	Hours needed (one-off) to learn new standards applicable to role (10 hours a year, 1 network)	0.54%	$1.0
17	Number of on-network locations needing new comms serving multiple networks	1,200	$10.8
18	Assumed cost per system (Year X)	$15,000	
19	Switch in road freight to rail Package A	2.7%	$44.6
20	Assumed relationship between rail use ad increase in maintenance costs	100%	
21	Number of standards (likely maximum)	143	$24.3
22	Inflated cost per standard to 2024 dollars	$185,234	

For instance, one of the most important assumptions in the model is the share of road freight that could switch to rail freight because of a more efficient rail service. We assume a 0.5% switch to rail for every 1% improvement in rail efficiency (see assumption 15). This leads, on the benefits side, to $258 million in annual benefits from reduced road damage, reduced emissions, and improved road safety. On the cost side it leads to $45 a million in higher rail maintenance costs, as we assume a 1:1 relationship between rail use and maintenance costs (see assumption 20).

As the table shows, we have opted for low estimates of benefits in most cases, to err on the side of caution in showing the gains possible from harmonisation.

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8. Harmonisation Priorities and Key Findings

Based on the analysis contained within this *Report,* the key finding by GHD is that:

1. A relevant national entity should lead the development of a National Rail Standards Harmonisation Strategy and accompanying Roadmap, based on the Preferred Option Pathway (Option 2: Gradualist Mandatory Pathway, as specified in Section 5.3.2, and including option-specific initiative implementation considerations). This Strategy and Roadmap should consider the identified key implementation considerations, as well as Option Pathway-specific initiative implementation considerations. This Strategy and Roadmap should also be developed in collaboration with RIMs and key RSOs, to establish a shared vision across the sector for the future of rail standards harmonisation.

Additionally, to enable a national standard-setting organisation to support greater harmonisation, GHD proposes the following priorities for further consideration:

2. The resourcing and capability needed for a fit-for-purpose national standard-setting organisation to ensure future standards are available to all and adopted across the industry. Membership and participation of RIMs in standard-development technical working groups are key issues.

3. A modified role of ONRSR through an amendment to the RSNL, to act as the enforcement entity for mandatory national standards under the Preferred Option Pathway.

4. Requiring relevant international standards to be evaluated first before any new Australian rail standard is developed, either mandatory or voluntary. International standards that are analogous to existing products should also be continually reviewed, identified and formally considered for adoption as national standards with only minor revisions (as needed for stakeholder-identified technical reasons). If deciding to not adopt a relevant, existing, international standard, a full justification for this decision should be consulted with industry.

5. Co-regulation under the RSNL should remain the regulatory structure of Australian rail networks for all standards that are not considered 'high benefit' enough to be mandated under the Preferred Option Pathway.

6. A legal mechanism to allow RIMs and RSOs to facilitate the orderly transition to a mandatory harmonised standards regime under the Preferred Option Pathway.

7. Once changes in specific standards are proposed to be nationalised, a Cost-Benefit Analysis (CBA) of this change should be undertaken to both ensure that the change is of high benefit, as well as determine the cost impact on individual RIMs. This consideration of cost impact should then be used to inform the extent and nature of Government support for industry in meeting the cost of change to comply with new standards, as established under the Preferred Option Pathway.

8. Conduct an internal audit and gap analysis of all RIMs and RSOs standards to the extent legally permissible, to inform national standard development and improve information sharing between networks under the Preferred Option Pathway.

Appendix

A

→Stakeholder Engagement Report

As part of the Harmonisation of Standards Research Project, a diverse range of rail industry stakeholders were consulted with through several workshops, interviews, and other forms of engagement. These stakeholders included representatives from major RIMs, RSO, and rail equipment suppliers. The outcomes of the engagement activities are recorded in a Stakeholder Engagement Report, which was then used to inform the Harmonisation of Standards Research Report.

While the Stakeholder Engagement Report is an important input to the Final Report, it records the names of individuals engaged with, as well as the organisations that they represented. As such, the Stakeholder Engagement Report will remain an internal document of the ARA, NTC, ONRIC, and RISSB. This is to maintain the privacy of these individuals and organisations consulted with throughout the Project, as well as to ensure that any outcomes of the consultation, or any opinions presented, are not directly linked to any individual or their organisation.

Appendix

B

→Initiative Long List – Strategic Analysis

Initiative Title	Initiative Detail	Benefit	Challenges / Issues	*Other / Supporting Considerations*
Greater government and industry alignment and promotion of voluntary adoption and implementation. This initiative addresses these barriers: – Lack of information sharing and collaboration.	– Additional funding and resources to enhance and accelerate the role of RISSB to increase facilitation.	– Lower cost to government and other stakeholders. – Enhances industry-wide awareness and encourages industry-led harmonisation and interoperability. – Potentially encourages collaboration between stakeholders in the rail industry.	– Risk of slow or non-existent benefit realisation due to the need for consensus and lack of enforcement. – Potential for conflicting interests among diverse stakeholders, meaning that coordination and management of forums and working groups would be complex. Without industry alignment, the outcome of consensus will be flawed. – Existing culture of RIMs being unwilling to collaborate and preferring to operate largely in isolation, within their jurisdiction's best interests.	– Need defined roles and responsibilities within working groups, as well as regular monitoring of progress. – Need to consider appropriate resourcing, including who provides the secretariat and/or mediator for technical working groups. – Stakeholders have noted that, outside select forums and ventures organised directly by RISSB, there were limited opportunities for formal and structured collaboration between stakeholders in the rail industry. – At the RSO's workshop, attendees believed that standards developed by RISSB are not sufficiently informed by RSOs needs relative to RIMs, and that RSOs are given little opportunity to provide input into their development process.
Greater harmonisation-specific stakeholder collaboration forums and technical working groups. This initiative addresses these barriers: – Lack of information sharing and collaboration. – Risk averse culture.	– Unlock further resources to hold greater collaboration forums and working groups related to standards harmonisation across different entities, beyond what already occurs.	– Promotes the development of technically feasible and widely accepted standards. – Enhances communication and understanding among stakeholders. – Increases visibility of information and removes barriers to accessing information. – Allows for standards development to be sufficiently informed by industry needs and helps reduce the gaps in RISSB's set of standards.	– The upfront investment (and hence incentive) required to align with harmonised standards could be significant. – National harmonisation benefits may not be achieved, even after early movers have been funded at a cost to government. – RIMs may not be willing to make the switch even through an incentive program if there are perceived risks to their network from harmonisation (i.e. safety or reliability) that are not addressed.	– Any incentive program should be designed to be scalable, allowing for expansion as more entities join the harmonisation effort. – Continuous engagement with stakeholders is crucial to address concerns and adapt the program to evolving industry dynamics. – Program would likely need to be funded by the Commonwealth, and could be directed to State Governments, given that the States (typically) have the levers necessary to compel RIMs to comply with national standards. – Would need to consider where the funding and resources come from to implement.
Incentive programs for early harmonised standards adopters. This initiative addresses these barriers: – There is minimal incentive to change. – Path dependence. – Compliance costs and commercial realities. – Risk averse culture.	– Funding incentives could deplete over time in advance of more prescriptive or mandatory compliance creating urgency and incentive to move early.	– Would help to overcome the 'first-mover' disadvantage of the collective problem of rail standards harmonisation, where no individual RIM is incentivised to change. – Reduces the significant cost constraints required for RIMs and operators to harmonise.	– The upfront investment (and hence incentive) required to align with harmonised standards could be significant. – National harmonisation benefits may not be achieved, even after early movers have been funded at a cost to government. – RIMs may not be willing to make the switch even through an incentive program if there are perceived risks to their network from harmonisation (i.e. safety or reliability) that are not addressed.	– Any incentive program should be designed to be scalable, allowing for expansion as more entities join the harmonisation effort. – Continuous engagement with stakeholders is crucial to address concerns and adapt the program to evolving industry dynamics. – Program would likely need to be funded by the Commonwealth, and could be directed to State Governments, given that the States (typically) have the levers necessary to compel RIMs to comply with national standards. – Would need to consider where the funding and resources come from to implement.
Establish a central directory or database for high benefit standards. This initiative addresses these barriers: – Lack of information sharing and collaboration.	– Create visibility across networks to show all standards in one place in a comparative format for high benefit standards, illustrating the detailed differences between standards.	– Would lead to a better understanding of the benefits and costs of harmonisation to the networks, and for RIMs to understand where 'quick wins' in standards harmonisation may exist. – Streamlines the process of locating and referencing standards for RIMs and RSOs, potentially facilitating better compliance and consistency across the industry. – Increases visibility of information and removes barriers to accessing information. – Could reduce complexity of navigating the various rules, regulations, policies, and procedures within each jurisdiction, which could help streamline type approval processes or improve safety outcomes.	– There is stakeholder resistance to sharing due to commercial-in-confidence considerations and concerns. – Difficult maintaining the currency and accuracy of the directory, as well as integrating various existing databases into a central system. This is an increased administrative task for RIMs, which they may not feel incentivised to undertake. – May not necessarily encourage uptake of high benefit standards if RIMs do not perceive these standards to maximise performance and minimise safety risk within their own networks.	– This is an alternative to mandating. If high benefit standards were mandated, there would be no need for a central directory as the mandatory standards would be widely known. – Register would need to be supported by regular review and a feedback mechanism, which facilitates proactive identification and pursuit of bridging gaps, or addressing inconsistencies, between networks. – The EU has functional and efficient information sharing mechanisms with readily available information on maintaining readily available registers on infrastructure, vehicles, national rules (i.e., non-harmonised standards), and other key technical information which could be considered as a model. – Initiative could have the effect of reducing the visibility and take up of perceived lower-benefit standards. – Would need to consider who manages the system, as well as a systematic way of determining a 'high benefit' standard.

Initiative Title	Initiative Detail	Benefit	Challenges / Issues	*Other / Supporting Considerations*
Regulation to mandate a limited range of specific standards. This initiative addresses these barriers: – There is minimal incentive to change. – Path dependence.	– High benefit standards are designed and mandated nationally.	– High compliance and benefit realisation potential through adequate enforcement. – Proven overseas examples of successful implementation, including in the EU (Directive (EU) 2016/797) and the USA, though under different models. – Reduces confusion and reduces challenges of navigating competing regulatory visions of different jurisdictions.	– Significant implementation challenges regarding stakeholder support, sequencing, and costs for process change and new equipment, as well as potential sunk infrastructure costs. – Would require high level of capability uplift for RISSB/national standard setting in the areas mandated. – There is a risk that a mandated set of harmonised standards would lead to a compromise in quality / be watered down / not be fit for purpose. – Perceived or actual loss of control for RIMs, and potential lack of clarity or consensus on individual RIM responsibility.	– Likely only feasible or beneficial with select number of mandatory standards (high benefit) for harmonisation within a realistic time horizon. – This could be benefit from a staged rollout, consistent derogations, and well-considered grandfathering/phase out and phase in arrangements (as is the case in the EU). – Legislation would need to allow for a reasonable transition period. – If mandared to 'in-flight' projects, this may bring project delays due to the expectation of change. – There should be ongoing engagement with industry stakeholders as part of the standards development and mandating process, to ensure standards meet industry needs. – A period of incentivised organic alignment may be preceded by a deadline for development and adoption of common standards. – Is international precedent per the EU Directive (EU) 2016/797 established revised 'Technical Specifications for Interoperability' (TSIs). – Is aligned with a priority area of action under the NRAP ("codifying a small number of critical national standards and rules"). – "Increasing RISSB's ability to mandate" listed as one of the most common ideas to increase member uptake of standards, in the RISSB member survey, conducted in 2022. – Would need to clarify liability issues.
Mandatory disclosure of derogation for non-standard projects and system changes. This initiative addresses these barriers: – There is minimal incentive to change. – Path dependency.	– The RIM is obligated to 'show-cause' for any deviation from what has been asserted as a high benefit standard for national adoption. – Justified derogations (where local/ bespoke standards are required need to be given against defined principles. – An independent entity may be required to approve derogations or adapt the standard to warrant the derogation unnecessary.	– Regulators making it difficult to not comply with national standards, so has a higher compliance and benefit realisation potential if implemented effectively. – Encourages adherence to standards by default.	– Allowing too many derogations could impede benefit realisation in key areas (i.e., interoperability). – May delay critical projects with unique needs. – May disincentivise development of innovative technologies that diverge from a harmonised standard. – Potential trade-off between safety and productivity objectives.	– A well-defined and nationally consistent change process for obtaining derogations is crucial to successful initiative implementation. – Should be coupled with positive incentives for compliance with mandatory standards. – Derogations could be managed centrally (rather than by an RTO) and each one have a high bar that must be met before being approved. – Approved derogations could wherever possible, be accompanied by a time bound and enforceable and auditable plan to work towards future compliance.
Government support for industry in meeting the cost of change to comply with new standards. This initiative addresses these barriers: – There is minimal incentive to change. – Path dependency. – Compliance costs and commercial realities. – Risk averse culture.	– Like incentivising early adoption of harmonised standards this initiative seeks to compensate costs related to moving to harmonised standards. – Funds may be administered via an independent grant's facility that conducts a rapid CBA based on a short form funding application. – Principles and terms of reference for funding are developed to provide increased certainty of outcome for applicants. – Funds may compensate for potential losses including administrative compliance costs, stranded assets cost, compliance costs.	– High potential for positive stakeholder support, since the costs of transitioning to harmonised standards are mitigated. – High compliance and benefit realisation potential through adequate enforcement.	– Potential high cost to government. – Risk of developing a dependency among RIMs and suppliers on Federal government aid. – RIMs may not be willing to make the switch even through an incentive program if there are perceived risks to their network from harmonisation (i.e. safety or reliability) that are not addressed. – Potential for system 'rorting' in the form of funding applications for costs which would otherwise have been incurred for business-as-usual regulatory risk exposure. – Risk of downstream impact to changing standards not being considered and leading to significant funding claims from operators.	– The extent of the cost to government would depend on the option pathway progresses and how it impacts RIMs and RTOs. – Support must be tiered based on the size and impact of RIMs, which needs to be evaluation. – Scope to be confirmed (i.e., could only apply to migration costs for RTOs that have to 'change'). – Initiative could be viewed as 'financial incentives for compliance', where financial 'reward' is provided for adhering to national standards. – Stakeholder feedback noted that "harmonising standards would be shouldered by both RIMs and RSOs, and there would be no incentive to change without government policy or subsidy put in place". – Parallels with the Commonwealth Government's roads policy, as a proxy reword for acceptance and implementation of PBS high-productivity vehicle permits across the national network.

Initiative Title	Initiative Detail	Benefit	Challenges / Issues	*Other / Supporting Considerations*
Project investors (governments) refusing to finance projects not using specific harmonisation standards. This initiative addresses these barriers: – There is minimal incentive to change. – Path dependence.	– Requiring interoperability compliance as a requirement in any co-funding agreements, as well as the provision that funding to RIMs is contingent on the application of standards.	– Strong incentive for harmonised standards to be used and, therefore, for associated benefits to be realised. – Aligns rail funding with national harmonisation goals.	– High potential for stakeholder backlash. – May limit funding for innovative but non-standard solutions. – May delay or inhibit funding for projects that would otherwise bring significant economic benefits to a jurisdiction. – Limited scope, as would only work for Commonwealth-funded projects.	– Need clear criteria for what constitutes 'harmonised standards' (whether mandated or otherwise). – Need to consider circumstances for exceptions (if any). – Need to clearly define and reach consensus on a national harmonisation goal and objective. – In the EU, there is a precedent for linking new infrastructure funding and renewals of infrastructure, with an alignment to ERA TSIs. To this end, there is a particular focus on issues like GSM-R, ETCS and the development of the TEN-T. – May put a cap on innovation.
Develop a formal automatic mutual recognition scheme for rollingstock and adopt national type approval framework with associated formal agreements. This initiative addresses these barriers: – There is minimal incentive to change. – Lack of information sharing and collaboration. – Path dependence.	– RIMs are incentivised or obligated to sign mutual recognition agreements whereby standards in other recognised networks are automatically accepted in their network. – Automatic recognition may have some defined limitations and may be restricted to high benefit standards.	– Would likely be well-supported by stakeholders, particularly in the case of type approvals where duplication is an issue. – Networks with most similarities would likely be most amenable to this initiative.	– Pre-existing technical harmonisation issues may hinder transferability and equivalence of standards, and there may need to be re-alignment prior to any mutual recognition scheme being established. – Requires alignment of technical standards that define both rolling stock approvals and TA, meaning there is potential resistance from regions with (perceived or actual) unique requirements. – Stakeholder disagreement on the content of approvals, especially if some are perceived to be less safe or unsuitable for their own network. – Requires a degree of pre-harmonisation to make effective given non-harmonised standards cannot be fully mutually recognised.	– Legal and governance framework will be needed to support mutual recognition, which specifies who would oversee approvals. The structure and governance of the entity responsible for approvals similarly needs to be determined (could be an independent, centralised body). – Needs agreement on common standards that govern rollingstock approvals and TA. This agreement can be in the form if mandatory standards (if implemented) or voluntary, if such voluntary agreement is possible. As a result, initiative more supports the delivery of harmonised standards, in conjunction with other initiatives. – Mutual recognition in the rail context has been partially progressed successfully in EU through the Office and Road and Rail in the context of Common Safety Method for Risk Evaluation and Assessment. – Costs of type approvals in Australia have been estimated at $230 million per year. – This initiative could be progressed by the NTC and could be realised in part with Government support for the RISSB National Rollingstock Register project. – In the EU, there is a precedent, given that a major focus of the ERA has been to centralise type approval across the EU.
Undertake a governance review to assess supporting arrangements, functions, and responsibilities that would be required to support any given option pathway for harmonisation. A governance review would consider all barriers identified.	– A governance review is likely required as part of any pathway towards harmonised standards. – A governance review may result in recommendations for a streamlined co-regulation system whereby there is increased centralised function and RIM's focus more effort in areas of low harmonisation benefit.	– A unified vision of governance will be needed for clarity and timely delivery of implementation. – Facilitates better coordination between different entities involved in harmonisation. – Ensures that governance structures align with the harmonisation vision. – Increased transparency, clarity and consensus on governance structure and responsibility for stakeholders.	– Standard harmonisation will inherently prompt a need to revise governance, but stakeholders may feel a loss of control and autonomy. – It will be resource intensive to disentangle the existing disparate governance mechanisms within the system. – Concerns could be mitigated by integrating current RIMS and regulators into the harmonisation process through a steering group. – Unlikely to realise any benefits on its own (purely a supporting initiative).	– Review is agnostic to option pathways, although the nature of the review would differ depending on which pathway is progressed. – Review should promote an appropriate set of governance arrangements, such as an expanded role of ONRSR, the establishment of a specific harmonisation Committee, or other, pending other initiatives being implemented. – Requires packaging with other initiatives to realise benefits. – Current lack of "a clear vision" and lack of visibility over governance responsibility cited as a principal frustration amongst stakeholders. – Would need to consider a mechanism to prevent the system from being 'gamed' by market participants.

Initiative Title	Initiative Detail	Benefit	Challenges / Issues	*Other / Supporting Considerations*
Mandate that national training units of competency, skills sets and qualifications be delivered in the context of a generic railway, which is supported by a Guidance document from ISA. This initiative addresses these barriers: – Lack of information sharing and collaboration.	– Harmonised standards would result in more consistent training however training programs could have increased emphasis in achieving accreditation for multiple jurisdictions. – Acceptance and implementation of recognised credentials and competencies.	– Enhances labour mobility through having transferable skills across a harmonised set of standards, working to mitigate identified skills shortages. – Reduced education costs as workers trained under one jurisdiction's standards do not need to be retrained. – Improved safety outcomes for workers operating across networks.	– Requires some alignment of technical standards that define disparate training regimes, meaning there is potential resistance from regions with (perceived or actual) unique requirements. – Developing a one-size-fits-all training program may not address specific regional and local training needs (acknowledging that there have been challenges with too much regional contextualisation to specific needs).	– – Package could be developed in collaboration with relevant educational institutions. – – Training relevant to rail organisation and/or RIM is to be supported by a national assessment framework agreed by industry for the relevant function – – Stakeholders have reported that training varies widely due to a geographic-specific practices, and the cost of training is increased through workers having to handle different network and system requirements.
Government investment in type approval technologies that help solve standards-related interface constraints. This initiative addresses these barriers: – Network operating differences.	– Government entities would proactively seek type approval for new componentry which will enable interoperability. – Build mutual recognition for technology approval processes.	– Would deliver key interoperability benefits where it is impactful.	– Technical limitations could impede the ability of this initiative to overcome prevailing infrastructure constraints. – Government might crowd out private investment to do the same, given that private investment to solve interface constraints is already ongoing. – Government risks 'backing the wrong horse' and losing taxpayer funds.	– – Could be supportive of the implementation of a national TA framework. – – Nature of investment allocation to be determined (i.e., direct engagement with industry and engagement with existing TA channels, or through developing its own TA process). – – The decision on implementation will be the prerogative of the funding agency and Department (Commonwealth).

Appendix

C

→MCA Detailed Results

C-1 Option Pathway 1 – Voluntary Pathway

MCA Criteria	Supporting / Justifying Consideration	Score
Cost	– No subsidisation is required, however, the degree of variability in harmonisation may impose more cumulative indirect costs on the industry by way of more permitted derogations and network interface issues through lack of interoperability. – While there is less cost for minimal/if any regulatory reform, there will be higher monitoring and evaluation costs through the need to track progress and reporting across self-nominated stakeholder accountabilities – There will be further costs to resource RISSB to take on an expanded role, though this may be in line or comparable with stronger resourcing for ONRSR under Options 2 & 3. – Voluntary standards directory will be costly to establish and maintain. This could be offset by mandatory RISSB membership. – More costly training programs, given more voluntary standards to cover.	7
Certainty	– The lowest likelihood of outcome due to voluntary nature and trust in enduring cross-industry consensus on voluntary standards areas. – Harmonisation outcome partially supported by positive and non-heavy-handed compliance measures. While this might minimise short-term industry burden, it may not suffice to sustain or incentivise long-term momentum in the same way conditional subsidies might in Options 2 & 3. – Contingent on a 'clear vision" for harmonisation given lack of mandatory measures. Indeed, the ARA "question the ability to meaningfully impact interoperability challenges constraining productivity within the current structure of authority shared by judications without achieving a step change in commitment to coordinated decision making in the national interest or major Commonwealth intervention".[308] – Historically, multi-jurisdictional forums and voluntary standards have failed to drive any meaningful improvement.	3
Stakeholders buy-in	– In principle, most stakeholders favour inclusive and co-design-friendly options through the wider availability of stakeholder forums beyond or as RISSB subcommittees. – Widespread stakeholder recognition of the value of RISSB standards and role as independent custodian. – However, despite this recognition, there have been previous issues with convergence around RISSB standards. As such, delivery partners may not want to comply – Stakeholders view all RIMs/ operators needing to be on board for it to be effective. This is something unlikely to be assured by a voluntary harmonisation pathway. – Additionally, there is no full uptake of voluntary standards through existing avenues, indicating a level of dissatisfaction with the current model. – Some RISSB standards are not commercially viable as they stand for stakeholders and a "best practice" review would need to be undertaken to promote better compatibility with business requirements.	6
Timeliness	– Standards and implementation timelines so variable as to potentially severely delay harmonisation outcomes and lead to higher levels of regional bureaucracy, potentially resulting from excessive proliferation of governance forums with no enforcement powers but diverging voices. – This would be the longest timeframe of all the options given the lack of any hard mandate and given there is unlikely to be significant accelerated traction arising organically.	4

308 Australasian Railway Association (ARA). Interoperability & Regulatory Issues in Australian Rail Freight. ARA, 2021. Pg., 5.

MCA Criteria	Supporting / Justifying Consideration	Score
De-risking	– Risks further fragmenting standards by allowing too lenient derogations, coupled with the lessened enforcement power – Does not directly reduce costs or risk to stakeholders, thus does not provide an incentive to harmonise from a burden reduction perspective. – The central standards directory inherent to this option partially mitigates risks to quality assurance by providing more accessible standards and a single reference point. However, mandated standards would encourage stricter adherence and non-negotiable QA. – More futureproofing given standards not locked in by a mandate and more standards setting forums to capture emerging best practice – Existing network interfaces and design requirements may act as a constraint to achieving interoperability given differences in voluntary standards cannot be tolerated or subject to a "bespoke interpretation" where infrastructure needs to be physically identical to link up to allow transport. As such, an interoperability assessment would be needed on voluntary standards as a precedent condition. – Voluntary standards could increase safety risks, though could be offset with more interpretive guidance as offered through the proposed training package and central standards directory initiative. – This is supported by the Taig Review noting that "the benefits of harmonisation will not be achieved by perpetuating diverse practices and re-badging them as 'compliant with national standards'	4
Efficiency	– More difficult to support a mutual recognition scheme without as much supporting prescriptive regulation, though could be set around RISSB standards as a less contentious starting point. – Furthermore, the option may stifle innovation by not having a consistent Type Approval process and supporting regulation to ensure mutual recognition. – Retains and bolsters the favoured co-regulatory component of the current system. – There may not be enough talent with existing skills presently to continually develop wide-ranging voluntary standards.	3
Weighted Score (two decimal places) [309]		**4.59**

309 Using weightings from the Pairwise assessment.

C-2 Option Pathway 2 – Gradualist Mandatory Pathway

MCA Criteria	Supporting / Justifying Consideration	Score
Cost	– Given is aimed at high benefit standards, may better provide for long-term costs through specifically focused areas of implementation vs the all-encompassing mandate of option 1, where funding may be spread thin. – Offers an improved ability to account for more proportionality of costs and assist with the cost burden given the more selective remit of option which is easier to quantify as opposed to more blanket funding. – In general, harmonizing the railways in accordance with the gradualist mandatory pathway is likely not to generate significant costs, given that the mandatory standards only apply to new vehicles (subsystems), as well as (conditionally) to renewed and upgraded subsystems.[310]	8
Certainty	– Established precedent in the EU TSI – demonstrating the viability of this option to achieve a level of harmonisation, albeit in an international context which is not fully transferable or applicable to the Australian context. – Will likely have higher uptake due to recognition of legacy infrastructure through grandfathering arrangements. – However, may have slightly less participation and uptake than a more expansive mandate, with less compelled urgency.	7
Stakeholders buy-in	– Stakeholders emphasised the importance of a balanced range of initiatives, from incentives through to hard mandates, to accommodate varied needs and maturity levels across the rail ecosystem. Of all the options, the gradualist pathway has the most hybrid and multi-lever toolkit to achieve this. – Gives stakeholders both the opportunity to shape the high benefit standards for endorsement, and to in turn enshrine them. Option 1 offers this enshrinement but without specificity and as much focus, while Option 3 offers a high degree of stakeholder consultation, but without as many avenues to ensure accountable progress.	7
Timeliness	– Only applies to new and upgraded systems, allowing for a more realistic and feasible implementation where legacy infrastructure may not be conforming. – Longer time horizon compared to Option 3 which may not keep pace with new industry developments and jeopardize future standards harmonisation, even though allowing for legacy infrastructure to be better adapted.	6
De-risking	– Transparent decision-making process around derogations with performance-based criteria for the show cause process. – Less onerous than option 3 and may better allow for value engineering for this reason.	6
Efficiency	– Focussed on areas with the greatest impact and is more strategic in scope, promoting efficiency. – Is more efficient within the existing resourcing and funding profile given the multi-year timeframe and grandfathering that would minimise wasted resources and set a more feasible rate of change. – Limiting the mandate to new equipment and systems allows for a forward-looking strategy that does not penalise existing operations that are compliant with the current regulatory regime.	7
Weighted Score (two decimal places) [311]		**6.89**

310 Cited in: European Union Agency for Railways. Costs of non-interoperability. European Union Agency, 2023. Pg., 20..
311 Using weightings from the Pairwise assessment.

C-3 Option Pathway 3 – Interventionist Mandatory Pathway

MCA Criteria	Supporting / Justifying Consideration	Score
Cost	– Lower cost for industry to adopt due to subsidies, though higher infrastructure costs for government. – However, further allocation of funding to subsidies and rail infrastructure far exceeds current levels given the speed and prescription of mandate and the potential need to decommission legacy infrastructure – Given the quantum of required funding, oversight and provision should be prosecuted through a carefully considered funding framework. This framework will be complex to equitably structure and require a benefits assessment prior. – However, high costs are critical for cushioning and mitigating the financial impact of the option and achieving ambitious harmonisation outcomes. – Nonetheless, high transition costs could lead to a dependence on subsidies which may not be sustainable long term. – Stakeholders view that commonwealth refusal to fund projects could be a useful lever and possible under the harder more interventionist mandate, although the federal government does not typically have this authority and usually provides provisional funding in advance.	3
Certainty	– For full realisation and certainty of outcomes, ONRSR would need to be empowered with stronger enforcement and monitoring powers to enshrine current high benefit standards, especially to deal with retroactive application and implications. The feasibility and regulatory impact assessment that would need to be conducted should be factored into this. – High certainty of harmonisation, but there may be secondary sub-optimal outcomes due to the speed and heavy-handed intervention of this option (i.e. legacy infrastructure being poorly retrofitted and adapted to conform with harmonised standards) – Level of available funding may impede certainty however and is contingent on securing additional capital outlay.	8
Stakeholders buy-in	– Stakeholders view that a mandate of some form is necessary at the outset of any harmonisation process, so would be supported at least initially. – Stakeholder view that would need to be implemented with a comprehensive training program to avoid poorly focussed or maligned outcomes. – Stakeholder view that would need to be enabled by a governance review to determine the accountabilities and liabilities of such an interventionist framework.	5
Timeliness	– Failure to capture regional nuances or necessary delays that might need to be accounted for due to higher challenges in some areas which are not possible to expedite. – Hard and fast timeframes may impede fulsome harmonisation due to the pace of implementation and lead to more inconsistencies in the long run.	9
De-risking	– The rapid transition may present operational challenges, particularly for RIMs with extensive networks and diverse equipment. Careful planning and phased implementation can help mitigate these challenges. – Harder to derogate under this pathway, with easy, non-meaningful derogations seen as a key risk to harmonisation by stakeholders. – However, more of a risk of choosing sub-optimal standards due to fast and hard timeframes, and a rigorous testing process is an especially important precedent implementation condition (though also applicable to a lesser extent to Option 2).	6

MCA Criteria	Supporting / Justifying Consideration	Score
Efficiency	– Development of new but worthwhile standards would be less efficient and effective given the high workload of implementing a wide suite of current standards, including retroactive application.	4
Weighted Score (two decimal places) [312]		**5.74**

312 Using weightings from the Pairwise assessment.

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