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Regulation of automated vehicles when in-service Cost-benefit analysis

REPORT

National Transport Commission

Cost-benefit analysis

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Contents

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Executive summary

This report has been prepared by PwC on behalf of the National Transport Commission (NTC) as an input to the NTC's Decision Regulation Impact Statement (RIS), *In-service safety for automated vehicles* (the Decision RIS). This analysis is an extension of the cost-benefit analysis (CBA) developed for the NTC's Consultation RIS, incorporating feedback provided by key stakeholders.

This document should be read in conjunction with the Decision RIS.

The purpose of this report

The report sets out the findings of a cost-benefit analysis of four different options for the future regulation of automated vehicles when they are 'in-service', that is after their initial supply to the Australian market. The NTC has developed the options with input from stakeholders to address two main problems:

1. Automated vehicles may introduce new in-service safety risks that the market will not eliminate or mitigate
2. Nationally inconsistent approaches to in-service safety and multiple regulators without clearly defined roles could be a regulatory barrier to market entry

The options considered in the report are:

- **Option 1** – Current approach (the baseline option): This option does not introduce any new safety duties or obligations for the in-service safety of automated vehicles at a national level. Instead, in-service safety is managed separately by each state and territory through existing regulatory frameworks.
- **Option 2a and 2b** –State and territory-based regulators enforce prescriptive safety duties (Option 2a) or a general safety duty (Option 2b) under state and territory laws based on a national model law.
- **Option 3** –A single national regulator enforces a general safety duty through Commonwealth law.
- **Option 4** –A single national regulator enforces a general safety duty through state or territory applied law.

Options 2b, 3 and 4 would introduce a general safety duty supplemented by some prescriptive duties where appropriate; for example, regulation of the dynamic driving task.

These options involve a range of different combinations of regulatory approaches, regulators and methods of legislating. To assess the options, each of these issues has been considered separately – with the main focus on establishing a need for regulation and determining the best regulatory approach. A secondary focus is on who the regulator should be and how to legislate to give effect to the preferred option.

1 **Establishing the need for regulation** – Option 1 relies predominantly on existing law or regulations, with some new, supporting duties at the State / Territory level. The other options all involve applying new duties to parties with a role in the in-service safety of automated vehicles.

2 **Determining the best regulatory approach** – Option 2a considers a regulatory approach involving 'prescriptive duties' on a range of parties who have an influence on the safety outcomes of automated vehicles, whereas Options 2b, 3 and 4 consider a regulatory approach involving a 'general safety duty' supported by some more prescriptive rules.

3 **Determining who is best placed to regulate** – Options 1 and 2 would involve States and Territories separately undertaking any regulatory tasks related to automated vehicles when they are in-service. Options 3 and 4 would involve a single national regulator undertaking this task.

4 **Determining the legislative approach** – Options 2 and 4 would involve State and Territory-based legislation. Option 3 involves Commonwealth legislation.

Additionally, the CBA considers the impact these four issues have on the likelihood of regulation contributing to a delay in the uptake of automated vehicles**.**

Challenges in undertaking this analysis

There have been some challenges in evaluating the four options. Firstly, there is uncertainty about the future of automated vehicles. Secondly, there is some uncertainty about the base case for the analysis, including how current laws will be applied to automated vehicles. In addition, it has been difficult to be precise about the impacts of the options, as they represent relatively high-level policy choices, with some detail which would need to be developed as legislation was drafted. Finally, there is limited quantitative evidence available to support the analysis, which has required us to make assumptions.

Overall, the approach adopted in this report has been to quantify as many of the impacts as reasonably possible and be transparent about the assumptions.

There are divergent views on the future of automated vehicles, including their benefits, how and when they will be rolled-out, how safe they will be etc. The approach has been to make reasonable assumptions in order to allow stakeholders to understand the relative significance of the different issues considered. There are a number of areas of the analysis where alternative assumptions about the future of the industry could have been used. However, as shown in the sensitivity analysis in Section 5.2, we have found that in most cases these assumptions would not affect the outcomes of the analysis or the conclusions we have drawn.

Key findings and the strength of these findings

The CBA compares the estimated impacts of the four options over a 20-year period from 2020 to 2039. It has been possible to quantify the following impacts:

- **The benefits of automated vehicles** – the roll-out of automated vehicles is expected to bring about significant benefits in terms of accident avoidance, productivity gains, congestion avoidance, and consumer savings through fuel savings and reduced insurance and parking costs. This report draws on a number of studies and has found the average benefits to Australia could be as high as **$64 billion per year** (when vehicles with automation level 3 or higher are fully adopted).[1] However, there is a lot of uncertainty about whether these benefits will be realised, so in the analysis of the options we have

[1] Benefits from automated vehicles consider vehicles with level 3 automation or higher given the majority of research quote benefits from vehicles with a level of automation where the driver does not need to monitor the dynamic driving task nor the driving environment at all times. Note however that level 3 automation needs a fallback ready user which may introduce new road safety risks.

taken the conservative approach of halving the benefits. We assume that automated vehicles will enter the Australian market in 2022 (in very small numbers), reaching a 2 per cent and 15 per cent uptake by 2025 and 2035 respectively. In the period from 2032 to 2039, there is assumed to be consistent growth in uptake to the point that 30 per cent of vehicles on the road will be automated vehicles of level 3 or higher by 2039.

- **The cost of a delay in the roll-out of automated vehicles** – the regulatory options alone won't deliver the benefits associated with automated vehicles, but they could bring forward or delay realising these benefits – either by incentivising or disincentivising the supply-of or demand-for automated vehicles. In this report, the estimated costs of a one-year delay in realising these benefits is **$4.7 billion to $9.4 billion** (over 20 years). However, as noted above, we have used the lower figure in the analysis. Overall, Option 1 has been assessed as most likely to result in a delay, and Option 3 as the least likely to result in a delay.
- **The safety impacts of the regulatory options** – the analysis assumes that effective in-service regulation could contribute around 5 per cent of the predicted safety benefits of automated vehicles. NTC analysis and stakeholder feedback on the Consultation RIS suggested that a general duty would be more effective than solely prescriptive regulation in controlling both known risks and unknown risks associated with automated vehicles. The safety benefits of prescriptive regulation have been estimated to be between **$121 million per year** and **$235 million per year** for the general duties approach (when vehicles with automation level 3 or higher are fully adopted).
- **The cost to government of regulating** – it is assumed that the annual cost of regulating automated vehicles when they are in service will be in the order of **$25 million per year** for a national regulator or **$50 million per year** for multiple state and territory-based regulators. The national regulator is assumed to be less expensive due to reduced duplication and greater economies of scale.
- **The cost to business of regulating** – businesses have been clear that regulation that is inconsistent with international approaches or is nationally inconsistent would make them less likely to supply automated vehicles to the Australian market – contributing to a delay in the uptake of automated vehicles. In addition to this, we have estimated that nationally inconsistent regulation will cost businesses around **$12 million per year** in additional compliance costs.

While there is uncertainty about the assumptions and figures used in the analysis, we are more confident about the relative scale of the different types of impacts. The analysis shows that delaying or bringing forward the roll-out of automated vehicles is the most significant issue, even when only counting half of the estimated benefits of these vehicles. The safety impacts of the different regulatory approaches is the next most significant issue, followed by the cost to government and business of the different regulatory approaches.

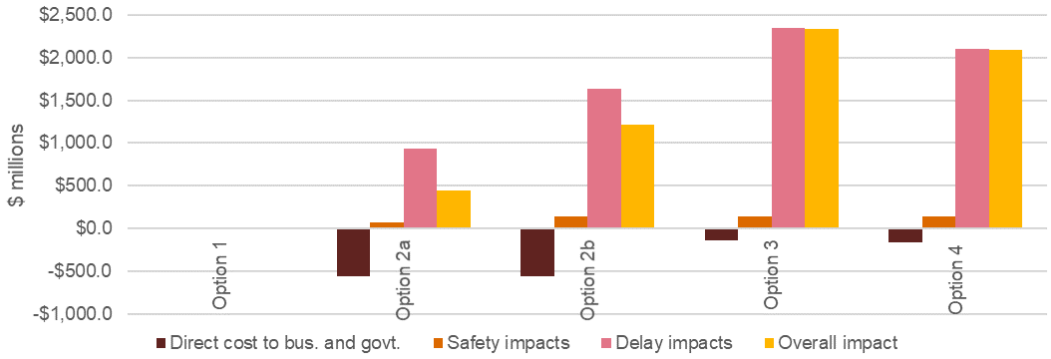
The table below summarises the quantitative assessment of the options. Notwithstanding the uncertainties, the analysis concludes that each of the regulatory options (i.e. Options 2a, 2b, 3 or 4) would be an improvement on the base case (Option 1). Option 3 has the highest net benefit, with anticipated net benefits of $2.34 billion over 20 years (2020 to 2039).

Summary assessment of the options (20 years, NPV 7%)

Option	Direct cost to bus. and govt.	Safety impacts	Delay impacts	Overall impact	Ranking of options
	$ millions	$ millions	$ millions	$ millions	Rank
1	$0.0	$0.0	$0.0	$0.0	5
2a	-$559.7	$72.2	$937.1	$449.7	4
2b	-$559.7	$139.6	$1,639.9	$1,219.8	3
3	-$143.1	$139.6	$2,342.8	$2,339.2	1
4	-$158.1	$139.6	$2,108.5	$2,089.9	2

The results of the CBA are useful in terms of demonstrating a comparison of each option to show the relative rankings. However, at this point in time, there is too much uncertainty surrounding automated vehicles and the future world in which they will be regulated to have a significant degree of confidence in the NPV values themselves.

Summary assessment of the options (20 years, NPV 7%)



Feedback on the Consultation RIS CBA

This CBA has been informed by evidence and feedback provided through submissions from key stakeholders to the Consultation RIS. Table 1 summarises the key feedback provided by stakeholders and how this feedback has been incorporated in this analysis.

Table 1: Key Consultation RIS feedback and change for this analysis

Impact area	Stakeholder feedback	Change for this analysis
Magnitude of benefits from automated vehicles	The assumption that automated vehicles will contribute $80 billion in annual benefits is potentially too large	Additional research included and Readiness Index incorporated to deliver a more conservative estimate of $64 billion in annual benefits
Rollout timeline	The rollout timeline of automated vehicles is likely to be further into the future, considering recent delays	Rollout assumed to begin in 2022, (in very small numbers), reaching a 2 per cent uptake in 2025 and 15 per cent in 2035.
Uptake timeline	The uptake timeline of automated vehicles is likely to be less smooth than the exponential path assumed	Smooth, exponential uptake trajectory updated to align to the introduction of different levels of automation and rollout timeline suggested through literature review.
Cost of different legislative approaches	The analysis may be able to distinguish between Options 3 and 4, as Commonwealth law is likely to lead to less inconsistency than State and Territory applied law or model law.	Analysis incorporates a 16 per cent reduction in costs to business and government, as well as a faster rollout under Commonwealth law due to increased consistency relative to other options.

Adjusting the approach to assessing the cost of different legislative approaches has enabled the analysis to distinguish between Options 3 and 4. The other three changes have made the analysis and results more accurate, without changing the ranking of the relative options.

In addition, stakeholders also highlighted the following challenges in quantifying different options for regulating automated vehicles when in-service:

- **Uncertainty and assumptions**: The cost and benefit estimates are assumption-driven given uncertainty regarding the future world in which automated vehicles are regulated.

- **NPVs as a relative ranking**: The NPV estimates are best interpreted as a relative scale of the issues considered in the CBA.
- **Uptake as the key driver of NPV**: The rate of uptake drives the ranking of options given the scale of benefits from automated vehicles.

These challenges are inherent in quantifying the impacts of regulating automated vehicles when in-service, given the uncertainty regarding the future world in which these vehicles will operate. We have therefore sought to provide as much additional clarity around these issues as possible, noting that they are still present in the quantitative analysis.

1 Introduction

This chapter sets out the purpose of this report, some relevant background information on the work that preceded this report, the project approach and proposed next steps.

1.1 Purpose of this report

This report sets out the findings of a cost-benefit analysis (CBA) of four different options for the future regulation of automated vehicles when they are 'in-service', that is after their initial supply to the Australian market.

The report and the CBA have been prepared by PwC on behalf of the National Transport Commission (NTC) as an input to the NTC's Consultation Regulation Impact Statement (RIS), *In-service safety for automated vehicles* (the Decision RIS).

The Decision RIS and CBA have been prepared in accordance with a Council of Australian Governments (COAG) decision that requires Governments and Ministerial Councils to establish and maintain effective arrangements that maximise the efficiency of new and amended regulation and avoid unnecessary compliance costs and restrictions on competition. This decision included requirements for the use of regulatory impact analysis and, where appropriate, CBA.[2]

The CBA has also been prepared to be consistent with:

- COAG's *Best Practice Guide to Regulation* (2007)[3]
- Department of Prime Minister and Cabinet, Office of Best Practice Regulation's (OBPR's) *Guidance Note on Cost Benefit Analysis* (2016)[4]
- Specific advice from OBPR on the approach to the Decision RIS and CBA.

1.2 Relevant work preceding this report

In November 2016, Australian transport ministers agreed to a reform program to achieve end-to-end regulation for automated vehicles in Australia.

Since then, the NTC has been leading a reform program to deliver a nationally consistent regulatory framework that both embraces innovation and ensures automated vehicles are safe.

The NTC has completed a range of work on the topic of regulating automated vehicles. In 2018, the NTC completed a RIS process that concluded with determining the approach to regulating automated vehicles at first supply (i.e. when they first enter the Australian market). The outcomes of this process are summarised below, as they provide useful background information for understanding this CBA.

1.2.1 November 2018 - Decision RIS

In November 2018, following approval by transport and infrastructure ministers, *The Safety Assurance for Automated Driving Systems: Decision RIS* was released. The RIS assessed

[2] See: http://ncp.ncc.gov.au/docs/Council%20of%20Australian%20Governments%20Meeting%20-%2010%20February%202006.pdf

[3] See: https://www.pmc.gov.au/sites/default/files/publications/COAG_best_practice_guide_2007.pdf

[4] See: https://www.pmc.gov.au/sites/default/files/publications/006-Cost-benefit-analysis.pdf

options for the safety assurance of automated vehicles to support their safe design and operation when they become ready for commercial deployment. Ministers agreed to the recommendations in the RIS including that the safety assurance approach for automated vehicles at first supply should be included in existing vehicle certification frameworks, allowing for alignment with international frameworks.

It was also agreed that further work would be undertaken to determine appropriate arrangements for in-service safety, including a more quantitative approach to determining the safety benefits and regulatory costs.

In particular, three key components of in-service regulation were highlighted as needing further development:

- Consideration of the appropriate in-service safety duties
- Consideration of the parties that duties should apply to
- Consideration of the institutional arrangements needed to govern in-service safety.

This decision has informed the development of the subsequent Consultation RIS and the approach to the CBA.

1.2.2 July 2019 – Consultation RIS

Similarly, in July 2019, the NTC conducted a Consultation RIS to seek feedback on the role and regulation of different parties involved in the safe operation of automated vehicles on Australian roads. The RIS considered safety duties that should apply to these parties, and the institutional and regulatory arrangements to support them. This has been part of NTC's roadmap to reform and develop a nationally consistent regulatory framework to support the safe commercial deployment of automated vehicles into Australia.

Based on the existing regulation and legal frameworks, there are gaps where the safe operation of automated vehicles is not adequately covered. The Consultation RIS discussed a series of regulatory approaches, accompanied by a CBA to address these issues.

Evidence and feedback provided by stakeholders on the following key issues has informed the changes to the CBA from the Consultation RIS:

- Magnitude of automated vehicle benefits
- Rollout timeline of automated vehicles given recent delays
- Consideration for the uptake of automated vehicle by consumers
- Cost of different legislative approaches.

1.3 Project approach

The following section describes the approach PwC has undertaken in developing the CBA.

1.3.1 Literature review

PwC has undertaken a review of the relevant literature and data sources to inform the CBA. This has included:

- Past work by the NTC
- Australian and international reports analysing the impacts of automated vehicles
- Previous RISs, which have considered similar issues

- Other relevant data sources.

The literature review informed the development of the assessment framework for the options and the quantification or discussion of the likely costs and benefits of each option.

1.3.2 Work with NTC

While PwC has been responsible for developing the CBA, the NTC has been responsible for developing the other components of the Decision RIS. This includes the 'problem statement' and the final set of options for evaluation. The CBA and the other components of the Decision RIS were developed concurrently, and PwC and the NTC have worked closely to ensure consistency between the two documents.

1.3.3 Stakeholder feedback

During the development of the Consultation RIS CBA, PwC undertook a series of consultations with a focus on:

- collecting further information about automated vehicles when they are in-service
- understanding the applicability and limitations of the current regulatory arrangements
- understanding potential costs and benefits of the proposed options
- collecting data to inform the quantitative analysis.

PwC consulted with State and Commonwealth government transport agencies, a transport regulator, an automotive manufacturer and transport industry bodies.

Stakeholder feedback was also gathered through submissions on the published Consultation RIS. Submissions were made both publicly and confidentially by government and industry stakeholders on a range of issues regarding the CBA and broader Consultation RIS. Feedback from submissions has been used to inform changes to this analysis.

The NTC and PwC have also engaged with OBPR throughout the development of both the Consultation RIS and Decision RIS CBA.

2 CBA methodology

This chapter sets out the approach to developing the CBA, including the key assumptions and data sources and a description of the framework used for the analysis.

2.1 Approach to developing the CBA

A CBA is an analytical tool used to measure the economic and social impact of government action and measure the 'net social benefits' that action might produce. CBA requires that all major costs and benefits of a proposal be quantified in monetary terms. This allows the outcomes for a range of options to be translated into comparable terms in order to facilitate evaluation and decision-making.

2.1.1 Steps taken to develop the CBA

A typical approach to developing a cost-benefit analysis is set out below. This is largely consistent with the approach used in this report:

1 Specify the set of options

2 Decide whose costs and benefits count

3 Identify the impacts

4 Predict the impacts over time

5 Monetise (attach dollar values to) the impacts.

6 Discount future costs and benefits to obtain present values

7 Compute the net present value of each option

8 Perform sensitivity analysis

9 Reach a conclusion.[5]

Further detail on each of these steps is set out below.

2.1.2 Challenges undertaking this CBA

Undertaking a CBA on options for regulating automated vehicles when they are in service is an inherently challenging exercise, for a number of reasons:

- **There is uncertainty about the future state of the industry** – automated vehicles are being trialled in a number of places around the world, but currently there is no established industry to measure the costs and benefits of regulation for. In particular, there is considerable uncertainty about:
  - The timing of the roll-out of automated vehicles
  - The future structure of the industry (e.g. market structure, vehicle ownership models).
- **There is uncertainty about the base case** – as identified in the Decision RIS, there are a range of existing laws and regulations that could be used to control the safety of

[5] See: https://www.pmc.gov.au/sites/default/files/publications/006-Cost-benefit-analysis.pdf

automated vehicles in the future, but determining the impact of these laws and comparing them to different regulatory approaches is difficult due to uncertainty about:

  - Baseline levels of safety for automated vehicles
  - How governments would apply existing rules
  - How businesses involved with automated vehicles will behave in relation to safety
  - How the behaviour of businesses would change in response to regulation.

- **The options represent high level policy choices, with some detail which would need to be developed as legislation was drafted**– the Decision RIS identifies two broad regulatory approaches for ensuring the safety of automated vehicles when they are in service (discussed below) – one based on prescriptive duties and one incorporating a general safety duty supported by some prescriptive rules – but there is uncertainty around:
  - How a general safety duty might be applied in practice (Appendix C of the RIS provides an illustrative general safety duty)
  - What prescriptive duties would involve (Appendix B of the consultation RIS provided illustrative examples of prescriptive duties)
  - What the implications of the approaches would be for the costs of regulating and for the regulated parties.
- **There is a need to consider regulatory approach and implementation issues concurrently** – the options consider the regulatory approach and the implementation of that approach at the same time; the choice about one may affect the other.
- **There is limited quantitative evidence available to support the analysis.**

Many of these issues are inherent to analysing the costs and benefits of policy options in a dynamic and emerging industry like automated vehicles. To do so requires us to make assumptions, even when there is limited information to base these on. The principles we have applied to develop the CBA is set out in the box below.

Box 1 – Principles used to develop the CBA

1. **Quantify as many of the impacts as reasonably possible –** even where there is considerable uncertainty about the impacts of the options, we have sought to quantify as many impacts as possible.
2. **Be transparent about the assumptions** – we have set out our assumptions transparently, so that stakeholders can view and critique these. A full list of assumptions is set out in Appendix A.
3. **Request additional evidence** – we used the Consultation RIS process to seek additional information and evidence, which has been incorporated into the decision-making process and this updated version of the CBA.
4. **Allow stakeholders to distinguish between the options** – our analysis is intended to allow stakeholders to understand the relative significance of the different issues being considered and provide them with enough information to form a view about their preferred option.

2.2 Specify the set of options

Four different options for ensuring the in-service safety of automated vehicles are considered in this CBA (Option 2 has sub-options). The NTC developed these options taking into account feedback from government and non-government stakeholders:

Box 2 – Options considered

- **Option 1** – Current approach (the baseline option): This option does not introduce any new safety duties or obligations for the in-service safety of automated vehicles at a national level.[6] Instead, in-service safety is managed separately by each state and territory through existing regulatory frameworks.
- **Option 2** –State and territory-based regulators enforce prescriptive safety duties (Option 2a) or a general safety duty (Option 2b) under state and territory laws based on a national model law.
- **Option 3** –A single national regulator enforces a general safety duty that is supported by prescriptive duties through Commonwealth law.
- **Option 4** –A single national regulator enforces a general safety duty through state or territory applied law.

Source: Developed by the NTC – additional detail is provided in Chapter 9 of the Decision RIS

Options 2b, 3 and 4 would introduce a general safety duty supplemented by some prescriptive duties where appropriate; for example, regulation of the dynamic driving task.

In evaluating the four options, the CBA is evaluating whether there is a need for specific regulation of automated vehicles when they are in service and, if specific regulation is needed, determine whether duties should be prescriptive or a general safety duty (supported by some more prescriptive rules). It also considers different options for implementing in-service safety regulations – both the legislative model and who should carry out the regulatory task.

Box 3 – Key issues for the CBA to consider

1. **Establishing the need for regulation** – Option 1 relies predominantly on existing law or regulations, with some new, supporting duties at the State / Territory level. The other options all involve applying new duties to parties with a role in the in-service safety of automated vehicles.
2. **Determining the best regulatory approach** – Option 2a considers a regulatory approach involving 'prescriptive duties' on a range of parties who have an influence on the safety outcomes of automated vehicles, whereas Options 2b, 3 and 4 consider a regulatory approach involving a 'general safety duty' supported by some more prescriptive rules.
3. **Determining who is best placed to regulate** – Options 1 and 2 would involve States and Territories separately undertaking any regulatory tasks related to automated vehicles when they are in-service. Options 3 and 4 would involve a single national regulator undertaking this task.

[6] However, as discussed in section 10.5 of the Decision RIS, state and territory governments would likely need to amend their regulatory frameworks for an automated vehicle to operate on the roads under option 1. Specifically, legislation would be needed to allow an ADS to complete the dynamic driving task.

4 **Determining the legislative approach** – Options 2 and 4 would involve State and Territory-based legislation. Option 3 involves Commonwealth legislation.

The NTC indicated in the consultation RIS that it is willing to consider options with different combinations of features (as long as they are feasible). For example, while the current options consider a prescriptive vs. general duties approach only in Option 2, the analysis of general vs. prescriptive duties is also transferable to Options 3 and 4. This possibility is also reflected in Figure 1, below.

How the key issues link to the NTC's problem statement

The NTC's Decision RIS has identified the following problem arising when automated vehicles become ready for deployment within our current regulatory environment:

1 they may introduce new in-service safety risks that the market will not eliminate or mitigate

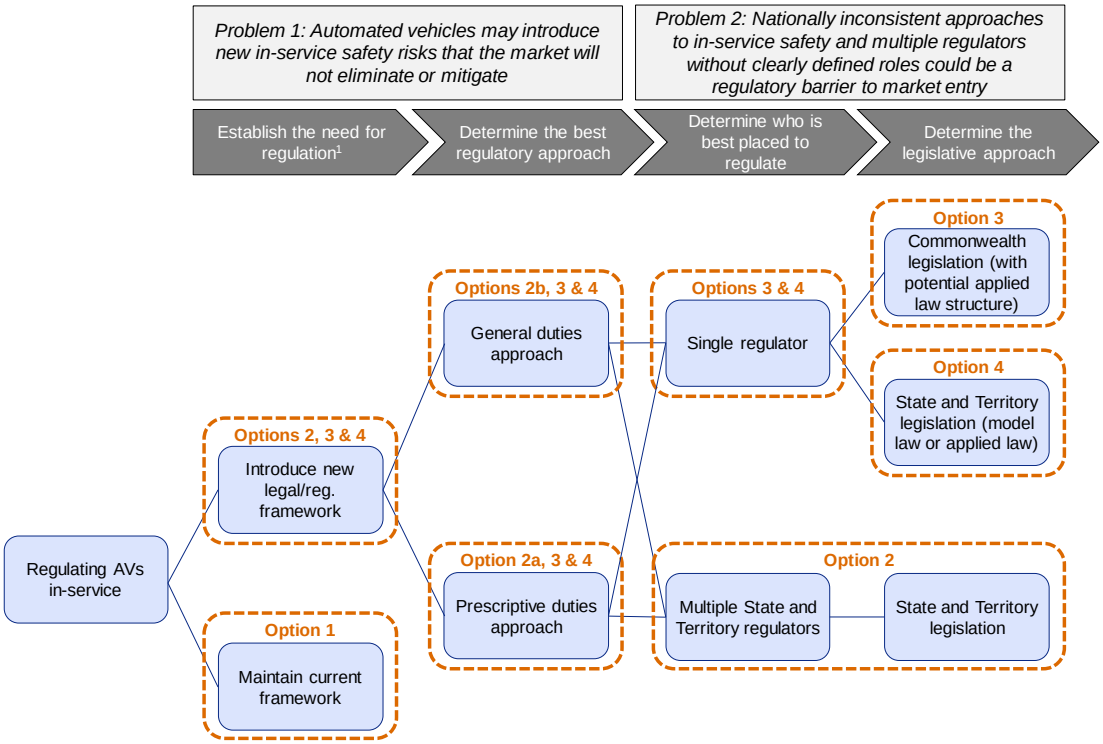
2 nationally inconsistent approaches to in-service safety and multiple regulators without clearly defined roles could be a regulatory barrier to market entry.

More detail about the problem, and how the options are intended to address it, is provided in Chapter 2 of the Decision RIS.

The first issue identified in Box 3 above, establishing the need for regulation, relates to both parts of the problem statement – safety and ensuring national consistency in the regulatory approach. The second issue, determining the best regulatory approach, primarily relates to the first problem the NTC has identified – safety. The third and fourth issues are implementation issues and primarily relate to the second part of the problem statement – ensuring there is national consistency in the regulatory approach.

The link between the options and issues the CBA is seeking to analyse is shown in Figure 1. More detail about the individual options is set out in Chapter 9 of the Decision RIS.

Figure 1: Options overview



Note: establishing the need for regulation is linked to both parts of the problem statement, even though it may be more closely linked to safety. Options 3 and 4 are described in Boxes 3 and 4 as relying on a general duties approach; however, Figure 1 reflects that the analysis of general vs. prescriptive duties in Option 2 is also transferable to Options 3 and 4.

2.3 Decide whose costs and benefits count

The CBA considers the impacts for three main groups in Australia. They are businesses; governments; and individuals and the broader economy:

- **Businesses** – the analysis of the impacts on businesses is focussed on the businesses that may be regulated under the options developed by the NTC. The NTC has made an assessment of the parties that are likely to have an influence on in-service safety of automated vehicles and may also be insufficiently covered by existing regulation. It has determined that automated driving system entities (ADSEs) and ADSE executive officers[7] are likely to have a 'major influence' (see Chapter 3 of the Decision RIS) and has designed the options to address the gaps it has identified in the current approach to regulating these parties. The choice of regulatory approach may affect other businesses (e.g. businesses that want to use automated vehicles), but these impacts are discussed under the 'individuals and the broader economy grouping'.

- **Governments** – the analysis of the government impacts has considered the impacts on the Commonwealth Government and the governments of the States and Territories, who would be responsible for developing the policy and legislative settings for automated vehicles when they are in-service as well as potentially regulating these vehicles under the options.

- **Individuals and the broader economy** – automated vehicles offer the possibility of fundamentally changing transport and society by improving road safety, mobility, freight

7 As described in Chapter 4 of the Decision RIS, executive officers within an ADSE company have been identified as a separate party. Executive Officers are the senior decision-makers within the ADSE.

productivity and potentially by reducing road congestion. This will have a broad range of impacts on individuals and the Australian economy, but the nature of these impacts is not always clear at this point in time. The analysis has considered existing research about these impacts, with a particular focus on how the choice of regulatory approach might impact the speed that automated vehicles are adopted and their safety.

2.4 Identify the impacts

This section considers in more detail the nature of the impacts the four options may have on the groups identified above. We have not been able to quantify all of the impacts in this section. Those we could not quantify, we discuss qualitatively in Chapters 3 and 4.

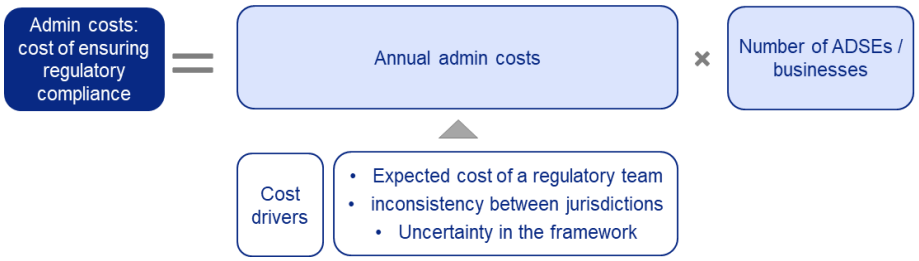
2.4.1 Business impacts

There are likely to be a range of administrative costs and substantive compliance costs for ADSEs and their executive officers under the four options.

Administrative costs

Administrative costs are the costs incurred by regulated entities primarily to demonstrate compliance with the regulation, for example record keeping and reporting costs.[8] Figure 2 below demonstrates the theoretical approach taken to understanding the administrative costs to business of the four regulatory options.

Figure 2: Administrative costs



Substantive compliance costs

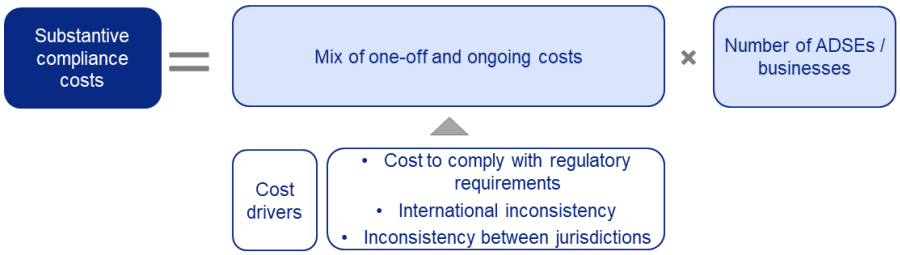
Substantive compliance costs are the costs incurred to deliver the regulated outcomes sought. For example, purchase and maintenance costs.[9] Figure 3 below demonstrates the theoretical approach taken to understanding the substantive compliance costs to business.

During consultations, representatives of vehicle manufacturers suggested that, as Australia is a relatively small market for automobiles globally, it is unlikely that ADSEs would make substantive changes to their processes to be able to operate in Australia. They suggested that the more likely scenario is that they wouldn't sell them in Australia or would delay their introduction. This has been considered in this CBA under section 3.6.

8 Department of Premier and Cabinet: OPBR (2016), *Regulatory Burden Measurement Framework*

9 Ibid.

Figure 3: Substantive compliance costs



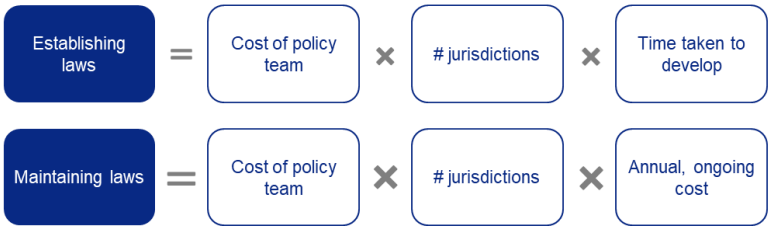
2.4.2 *Government*

The key costs to all levels of government associated with the regulation of automated vehicles when they are in-service include establishing and maintaining the regulatory framework (e.g. the laws and regulations); and establishing an entity to undertake the regulatory task and ensure ongoing regulatory compliance.

Establishing and maintaining laws

Figure 4 below demonstrates a theoretical approach to calculate the cost to government of establishing and maintaining laws. However, as these costs are relatively minor in the overall CBA, they have not been quantified.

Figure 4: Cost of establishing and maintaining laws

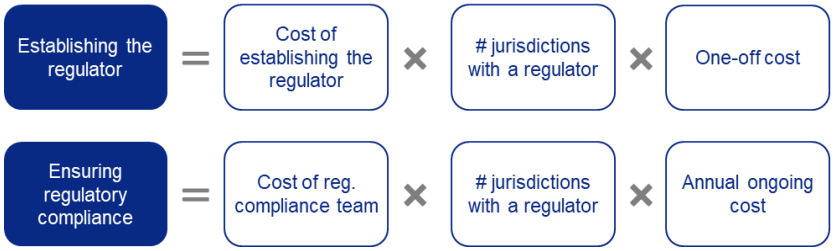


Establishing the regulator and ensuring regulatory compliance

Each option presents different costs to government in terms of establishing the regulator and ensuring regulatory compliance. These costs relate to the overall cost of establishing the regulator and the cost of a regulatory compliance team.

Figure 5 below demonstrates the approach taken to calculating the cost to government of establishing the regulator and ensuring regulatory compliance.

Figure 5: Cost of establishing the regulator and ensuring regulatory compliance



2.4.3 *Individuals and the broader economy*

At this point in time, it is difficult to predict the overall impact automated vehicles will have on individuals and the broader economy. There is uncertainty around the timing of commercial deployment, their initial uses, the structure of the market for their use and many other issues.

A key area of potential benefits from the introduction of automated vehicles is safety. Recent research suggests automated vehicles have the potential to largely eliminate transport crashes resulting from human error when fully adopted, which may create savings of $16 billion per year (these studies assume a future state where automated vehicles have fully replaced driver operated vehicles, which could be decades away).[10] A report prepared for the NSW State Insurance Regulatory Authority estimates that adopting automated vehicles in Australia will reduce the likelihood of injuries for:[11]

- car driver and passenger injuries by 80 per cent
- cyclist injuries by 70 per cent
- motorcyclists by 40 per cent
- pedestrians by 45 per cent.[12]

Other studies often identify the potential for automated vehicles to significantly reduce the 90-95 per cent of crashes caused by human factors when they are fully adopted.[13] However, there are no definitive figures on the safety benefits of automated vehicles because the technology is still being developed and there is nowhere in the world where these vehicles have been fully adopted.

Studies have also identified a much broader range of benefits from automated vehicles, such as those listed in Table 2.

Table 2: Potential impacts of automated vehicles

Impact area	Description	Direction of impact
Accident avoidance	Safety features of Automated vehicles will lead to fewer crashes	Positive
Productivity	Automated vehicles will enable productive use of travel time such as working while in transit	Positive
Public benefits	Other public benefits such as congestion avoidance, better use of urban space, energy management and impact on property values	Positive
Consumer savings	Benefits to consumers such as reduced fuel usage by automated vehicles and reduced insurance and parking costs (e.g. because self-driving vehicles may not need to always park)	Positive
Industry gains	Benefits to select industries such as technology companies (who create and maintain automated vehicle technology), trucking (who save on wages)	Positive

10 Pettigrew (2016), Why public health should embrace the autonomous car

11 See: https://www.sira.nsw.gov.au/resources-library/green-slip-resources/publications/scheme-reports/Finity-Report-on-Autonomous-Vehicles.pdf

12 Note, these studies of the expected benefits delivered by automated vehicles are often of future states where automated vehicles have fully replaced driver-operated vehicles. The gains over time prior to this point would be gradual and proportionate to the extent of the rollout.

13 For example, see: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf; https://www.aph.gov.au/Parliamentary_Business/Committees/House/Industry_Innovation_Science_and_Resources/Driverless_vehicles/Report/section?id=committees%2Freportrep%2F024056%2F24918#footnote10target; https://infrastructure.org.au/wp-content/uploads/2017/09/AV-paper-FINAL.pdf

Impact area	Description	Direction of impact
Industry losses	Losses to industry such as automotive repairers who repair less crashes	Negative
Costs	Infrastructure investments and road maintenance costs will rise	Negative

Source: Compass Transportation and Technology, Inc (2018), *The Economic and Social Value of Autonomous Vehicles: Implications from Past Network-Scale Investments*

This CBA is focussed on a relatively narrow aspect of automated vehicles – that is, the in-service approach to regulating these vehicles and more specifically, the differences between the options that have been developed by the NTC.

Therefore, we have not sought to undertake an exhaustive analysis of the potential uses and benefits of the vehicles themselves. Instead, we have drawn on a number of existing studies from Australia and from overseas, which have estimated the overall benefits of automated vehicles to the economy of a country. The studies we have considered are:

- Morgan Stanley, *Tesla's new Path of Disruption*, (2014) – USA
- KPMG, *Connected and Autonomous Vehicles – The UK Economic Opportunity*, (2015) – United Kingdom
- Conference Board of Canada, *Automated Vehicles: The Coming of the next Disruptive Technology*, (2015) – Canada
- Securing America's Future Energy (SAFE), *America's Workforce and the Self-Driving Future*, (2018) – USA
- The Society of Motor Manufacturers and Traders (SMMT), *Connected and Autonomous Vehicles*, (2019) – United Kingdom
- Australian Driverless Vehicle Initiative, *Position Paper: Economics Impacts of Automated Vehicles on Jobs and Investment* (2016) – Australia
- Infrastructure Partnerships Australia, *"Automated Vehicles, do we know which road to take?*, (2017) – Australia

Approach to estimating the value of automated vehicles to the Australian economy

We have used information from these studies to estimate the annual value of automated vehicles to the Australian economy in the benefit categories listed in Table 2. For the international studies, this has involved

- Converting the figures in the study to Australian dollars using the exchange rate of the relevant year
- Inflating figures from earlier studies to 2019 dollars
- Adjusting the figures to reflect the size of the country where the study was undertaken, based on the size of the country's vehicle fleet compared to Australia's vehicle fleet in 2018.

- Adjusting the benefits to reflect the country's preparedness for introduction of automated vehicles in comparison to Australia using KMPG's 2019 *Autonomous Vehicles Readiness Index*.[14]

As shown in Table 3, the studies estimated the annual benefits of automated vehicles in the range of $53 to $84 billion, with an average of $64 billion. This is significant in terms of the size of the Australian economy, potentially in the order of 4-5 per cent of Gross Domestic Product (GDP).

Studies quote annual benefits based on automated vehicles of level 3 or higher having been fully adopted. This is because level 3 automation is advanced enough to deliver significant benefits since the driver does not need to monitor the dynamic driving task or the driving environment at all times.[15] Our analysis has shown full adoption of automated vehicles of level 3 or higher to be several decades away.

[14] The Autonomous Vehicles Readiness Index is a tool to help measure 25 countries' level of preparedness for introduction of AVs. It is a composite index that uses 25 different measures to provide a single score.

[15] KPMG, *Connected and Autonomous Vehicles – The UK Economic Opportunity*, (2015) – United Kingdom

Table 3 Annual value of automated vehicles to the Australian economy, if fully adopted (2019 AUD billion)

		Benefit category								
Source	**Readiness index rank**	**Productivity**	**Consumer savings**	**Accident avoidance**	**Public benefits**	**Industry net gain**	**Taxes**	**Cost**	**Total**	**Year of full AV adoption**
Morgan Stanley, "Tesla's new Path of Disruption", (2014)	0.84	32.84	10.23	31.61	9.65	--	--	--	84.33	2030
KPMG, "Connected and Autonomous Vehicles – The UK Economic Opportunity," (2015)	0.88	13.22	4.41	1.76	31.72	1.76	1.76	-9.69	44.94	2030
Conference Board of Canada, "Automated Vehicles: The Coming of the next Disruptive Technology," (2015)	0.96	20.03	2.59	37.71	5.03	--	--	--	65.21	N/A
Securing America's Future Energy (SAFE), "America's Workforce and the Self-Driving Future," (2018)	0.84	12.54	5.57	31.56	15.49	--	--	--	65.16	2050
The Society of Motor Manufacturers and Traders (SMMT), "Connected and Autonomous Vehicles", (2019)	0.88	12.77	5.11	1.70	36.60	1.70	3.40	-8.51	52.77	2030
Australian Driverless Vehicle Initiative, "Position Paper: Economics Impacts of Automated Vehicles on Jobs and Investment" (2016)	1.00	--	--	28.01	55.29	--	--	--	83.29	2031
Infrastructure Partnerships Australia, "Automated Vehicles, do we know which road to take?," (2017)	1.00	--	--	4.69	--	--	--	--	4.69	2030
Average		**18.28**	**5.58**	**19.58**	**25.63**	**1.73**	**2.58**	**9.10**	**64.28**	

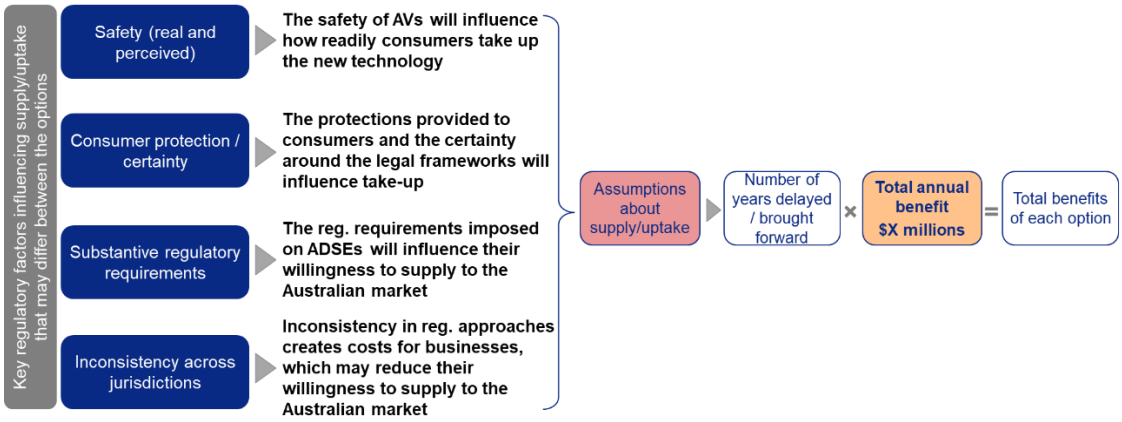
Note: The studies used a range of different definitions for their categories of benefits of costs " -- " indicates this was not category that was included in the analysis. Consumer savings includes consumer savings such as fuel savings and reduced insurance and parking costs. Public benefits include congestion avoidance and broader economy benefits.

Use of the benefits estimates in the CBA

As noted above, the purpose of the CBA is to evaluate the four options for regulating automated vehicles when they are in-service, not to estimate the overall benefits of automated vehicles.

This CBA deals with one aspect of the regulation of automated vehicles – their in-service operation. Feedback from stakeholders is that the options have the potential to delay or expedite the uptake of the automated vehicles, so the CBA has focussed on quantifying the costs and benefits of changes in the timing of uptake. The approach to estimating this is shown below and is discussed further in the following chapter.

Figure 6: Approach to estimating delay costs



2.5 *Predict the impacts over time*

Realising the potential benefits of automated vehicles depends on their rollout and uptake, this CBA has looked at how the different options might delay or bring forward uptake of automated vehicles by looking at two issues: consumer demand for automated vehicles and business willingness to supply automated vehicles to the Australian market.

2.5.1 *Consumer demand*

The rate of automated vehicle adoption will be, in-part determined by the public's willingness to adopt the new technology. This can be influenced by:

- **The safety of automated vehicles**: Consumers will likely have high expectations of safety for automated vehicles and unless they are safe, people will not adopt the new technology. This has been demonstrated in the public's response to a number of recent surveys regarding their safety expectations for automated vehicles.

  A 2018 survey found that 37 per cent of female and 28 per cent of male respondents expect that self-driving vehicles should be 100 per cent safe and will never be involved in a collision.[16] This is a much higher expectation of safety than for conventional vehicles. In a separate survey, a third of respondents identified safety concerns as the biggest obstacle to the growth of automated vehicles in the next five years.[17] More supporting evidence regarding the concern that the public has towards the safety of automated vehicles is included in Chapter 2 of the Decision RIS.

[16] Eastlink (2018), EastLink's 2018 Annual Victorian Self-Driving Car Survey

[17] Perkins Coie LLP & AUSVI (2019), 2019 Autonomous Vehicles Survey Report

The CBA discusses the potential safety outcomes associated with the different options and how this in-turn might affect uptake.

- **Consumer protection/certainty**: as highlighted in Chapter 4 of the Decision RIS, there are a number of gaps in the current regulatory and legal frameworks for automated vehicles. Uncertainty about the legal responsibilities and protections for automated vehicle users may be a factor that influences the rate of uptake of the vehicles and has been considered in the CBA.

2.5.2 *Business willingness to supply*

The rate of automated vehicle adoption will also be influenced by businesses' willingness to supply the technology to the Australian market. This can be influenced by:

- **Substantive regulatory requirements**: the regulatory requirements for automated vehicles when they are in-service may be a disincentive for ADSEs supplying automated vehicles to the Australia market. Based on the types of companies that are currently developing automated vehicle technologies, automated vehicles will most likely be developed overseas for global markets. As Australia comprises just 1-2 per cent of the international vehicle market, [18] international suppliers may not be willing to make substantial changes to their processes to comply with regulatory requirements that are not in-line with major world markets, which would in-turn delay uptake.

- **National inconsistencies in regulation**: another disincentive for businesses' willingness to supply is inconsistent regulatory approaches across jurisdictions in Australia, which would have the effect of further fragmenting Australia's automotive market. Previous submissions to NTC papers suggest this would be a strong disincentive for ADSEs to supply automated vehicles to Australia. This was re-stated in consultations conducted for the purposes of developing this CBA, as well as in the submissions to the Consultation RIS.

  In the US, industry have commented on the need and importance of a single uniform set of laws and regulations across jurisdictions. This is highlighted by Google in its testimony to the Senate Committee on Commerce, Science Technology:[19]

  'If every state (in the U.S.) is left to go its own way without a unified approach, operating self-driving cars across state boundaries would be an unworkable situation and one that will significantly hinder safety innovation, interstate commerce, national competitiveness, and the eventual deployment of autonomous vehicles'

  Jurisdictions with different testing, approval and regulations will likely result in varying rates of deployment.[20] Volvo noted the need for a consistent set of uniform laws stating '[t]he absence of one set of rules means car makers cannot conduct credible tests to develop cars that meet all the guidelines of all 50 US states'.[21]

2.6 *Estimate the results*

In this CBA, we have attempted to quantify as many of the impacts of the options as possible, but have needed to combine this with qualitative information where there was either

[18] See: http://www.oica.net/category/sales-statistics/

[19] Urmson (2016), Testimony of Dr. Chris Urmson, Director, Self Driving Cars, Google Before the Senate Committee on Commerce, Science and Technology Hearing" Hands Off: The Future of Self-Driving Cars"

[20] Litman (2018), Autonomous Vehicle Implementation Predictions Implications for Transport Planning, Victoria Transport Policy Institute

[21] Volvo (2015), US urged to establish nationwide Federal guidelines for autonomous driving, accessed via https://www.media.volvocars.com/global/en-gb/media/pressreleases/167975/us-urged-to-establish-nationwide-federal-guidelines-for-autonomous-driving

insufficient data to quantify the impacts or not enough information to make an informed assumption. The results of the CBA are presented in the following two chapters.

2.6.1 Monetise (attach dollar values to) impacts

Converting all of the costs and benefits to dollar values allows for a comparison of the overall impact of the options. This is set out in Chapter 4.

2.6.2 Discount future costs and benefits to obtain present values

In accordance with the OBPR guidance material, a 7 per cent discount rate has been applied over a 20-year time horizon. A 20-year time horizon has been chosen because the uptake of automated vehicles has the potential to skew the costs and benefits of regulating in the short term.

2.6.3 Compute the net present value of each option

The net present value (NPV) of each option is the sum of the value of the costs and benefits over the next 20 years (from 2020 to 2039) in today's dollars, using a discount rate of 7 per cent.

2.6.4 Perform sensitivity analysis

Sensitivity analysis is conducted to test the robustness of results and provide insight about how changes in different variables will affect the overall cost benefit analysis. In particular, five scenarios have been applied to the CBA, which align to OBPR's guidance material:

- Sensitivity 1: 3 per cent discount rate
- Sensitivity 2: 10 per cent discount rate
- Sensitivity 3: 10-year appraisal period
- Sensitivity 4: 25 per cent of delay impacts realised
- Sensitivity 5: 50 per cent of safety benefits realised.

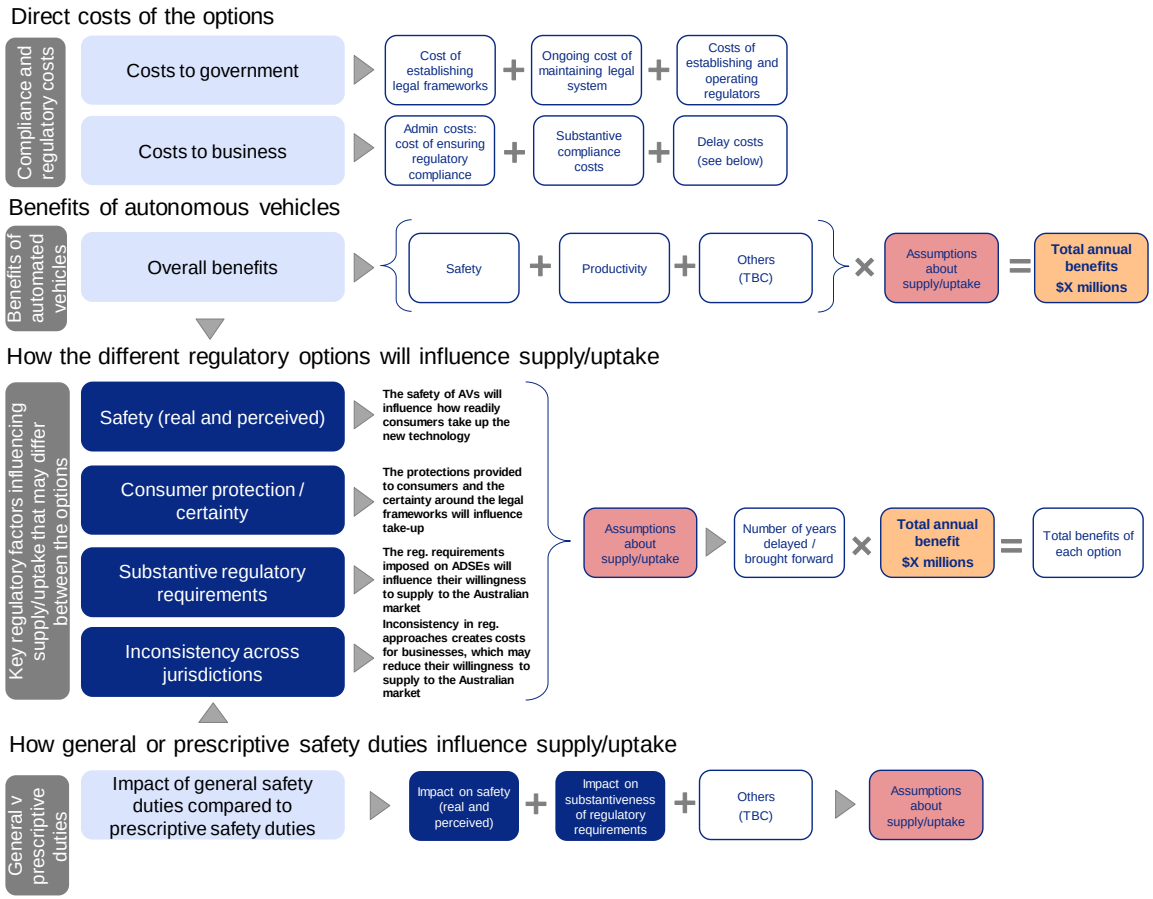
2.7 Reach a conclusion

The conclusions of this analysis are based on a mix of qualitative and quantitative analysis set out in Chapter 5 of the report. PwC and the NTC have also incorporated feedback and evidence provided through submissions in updating the CBA for the Decision RIS.

2.8 Summary of the framework for the analysis

The CBA framework is summarised in the figure below. The next section shows how this framework and the options address the key issues of the CBA.

Figure 7: CBA framework



3 Key issues being addressed by the options

This chapter analyses the four key issues considered in the CBA and Decision RIS, and analyses the costs and benefits that are specific to these issues.

3.1 Overview of the key issues

The purpose of the Decision RIS and the CBA is to understand the differences between the costs and benefits of the four options the NTC is considering. In doing so, there are four main issues that need to be considered:

Box 4 – Key issues for the CBA to consider

1 **Establishing the need for regulation** – Option 1 relies predominantly on existing law or regulations, with some new, supporting duties at the State / Territory level. The other options all involve applying new duties to parties with a role in the in-service safety of automated vehicles.

2 **Determining the best regulatory approach** – Option 2a considers a regulatory approach involving 'prescriptive duties' on a range of parties who have an influence on the safety outcomes of automated vehicles, whereas Options 2b, 3 and 4 consider a regulatory approach involving a 'general safety duty' supported by some more prescriptive rules.[22]

3 **Determining who is best placed to regulate** – Options 1 and 2 would involve States and Territories separately undertaking any regulatory tasks related to automated vehicles when they are in-service. Options 3 and 4 would involve a single national regulator undertaking this task.

4 **Determining the legislative approach** – Options 2 and 4 would involve State and Territory-based legislation. Option 3 involves Commonwealth legislation.

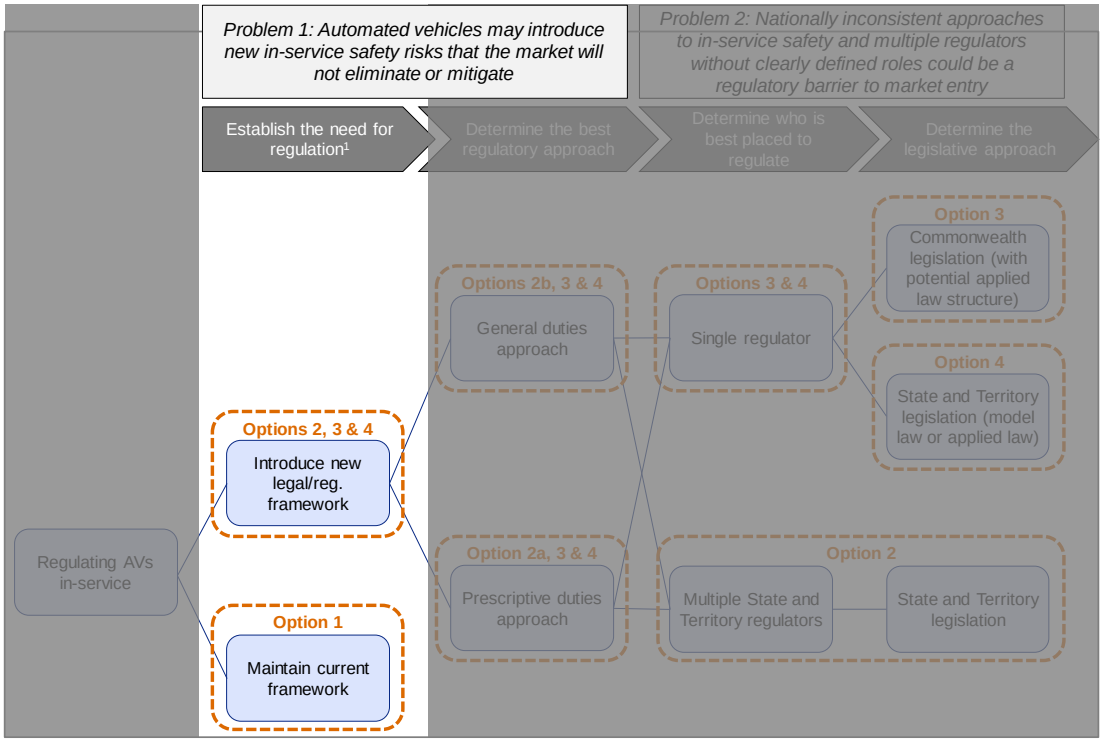
Additionally, the CBA considers the impact these four issues have on the likelihood of a delay in the uptake of automated vehicles**.**

[22] While the current options consider a prescriptive vs. general duties approach only in Option 2, the analysis of general vs. prescriptive duties is also transferable to Options 3 and 4.

3.2 Establishing the need for regulation

This section analyses the need for specific regulation of automated vehicles when they are in-service, relative to what could be expected to occur under existing legal and regulatory frameworks.

Figure 8: Establishing the need for regulation



3.2.1 Overview of the issues

The introduction of automated vehicles is expected to drive a broad range of benefits to society, particularly in terms of safety. It is often estimated that around 90-95 per cent of road crashes are the result of human error or other human factors (e.g. speeding, fatigue, alcohol etc.).[23] Automated vehicles have the capacity to significantly reduce these types of crashes when they are fully adopted, but they are not without their own risks. To-date, there have been at least four deaths involving vehicles with automated functions. Three of these deaths involved the drivers of level 2 vehicles,[24] and one involved the death of a pedestrian, who was struck by a level 3 trial vehicle.[25]

There are a number of existing legal and regulatory frameworks that will impact the likely safety outcomes of automated vehicles when they are in-service. As discussed in the Decision RIS, these existing laws and regulations will apply to various extents to ADSEs and their executive officers. While automated vehicle safety will be regulated at first supply under the Road Vehicle Standards Act, there will be a gap in regulating the in-service safety of

[23] See: https://www.nrspp.org.au/resources/human-error-in-road-accidents/

[24] A vehicle with level 2 automation have the capability to simultaneously control steering and speed for short periods of time without driver intervention, whereas a vehicle with level 3 automation is capable of taking full control and operating during select parts of a journey under certain operating conditions. Levels of automation are discussion in more detail in Chapter 1 of the Decision RIS.

[25] The Economist (2018), Why Uber's self-driving car killed a pedestrian, accessed via: https://www.economist.com/the-economist-explains/2018/05/29/why-ubers-self-driving-car-killed-a-pedestrian

automated vehicles, as market forces are unlikely to be sufficient to eliminate or adequately mitigate all new in-service safety risks.

ADSEs and their executive officers will also have some incentive to provide for the in-service safety of automated vehicles through established frameworks, such as negligence, consumer protection, and work health and safety legislation. Established frameworks are unlikely to comprehensively or effectively ensure in-service safety, as there are gaps and inadequacies in current regulation. The most significant gaps relate to regulation of new parties and road users, such as ADSEs, ADSE executive officers, remote drivers and fall-back ready users. In addition, Australian communities have an expectation that automated vehicles will be safe and that governments have a key role in ensuring automated vehicle safety (both at first-supply and in-service).

A further complication arises from the fact that multiple regulators may have a role in regulating in-service safety within each State and Territory, and it is not clear what the role and responsibilities of each regulator would be. As discussed in Chapter 2 of the Decision RIS, there is a risk that inconsistent regulatory approaches may emerge without a nationally coordinated approach. This may involve multiple, overlapping regulators resulting in unnecessary and avoidable compliance costs to ADSEs and other parties with a role in the in-service safety of automated vehicles. If safety issues arise with automated vehicles, this lack of clarity could mean multiple regulators choose to take action (resulting in duplication of effort) or increasing the safety risks if no regulator takes responsibility.

A lack of regulation specific regulation for the in-service safety of automated vehicles could also impact business. As discussed in Chapter 2 of the Decision RIS, businesses operating in Australia have an expectation that regulations will be both efficient and effective, and not introduce unnecessary costs, barriers or burdens. The emergence of inconsistent regulatory approaches may lead to significant unnecessary and avoidable compliance costs that may form a barrier to market entry. Australian consumers would therefore not receive the benefits of new automated vehicle technology. For these reasons, governments are justified in taking a coordinated and proactive role to provide nationally consistent oversight of automated vehicle in-service safety.

Finally, the NTC's problem statement outlines potential market and regulatory failures for in-service safety that are not adequately addressed by Australia's current regulatory framework. This again suggests that government intervention is warranted. This notion has been reiterated in the Productivity Commission's draft report on National Transport Regulatory Reform, which specifically identifies the need for new regulation specific to automated vehicles.[26]

3.2.2 Feedback from stakeholders

There was no clear consensus from stakeholders about how the existing laws and regulations would work in relation to automated vehicles. However, some stakeholder observations included:

- Some business stakeholders did not recognise the need for specific regulation on ADSEs and other key parties, on the basis that the automated vehicle should become the responsibility of the individual after purchase.

- The types of companies that are currently developing automated vehicles are typically major technology or automotive manufacturing companies and have a strong commercial and reputational interest in ensuring their vehicles operate safely. Some industry stakeholders engaged throughout the Consultation RIS expect these companies would operate to a high level of safety, regardless of the specific regulatory requirements.

[26] Productivity Commission (2019), National Transport Regulatory Reform Draft Report

- ADSEs and their executive officers will have a range of in-service duties under existing laws, which will incentivise them to maintain a high level of safety. Some specific examples include:

  – Workplace Health and Safety (WHS) laws – e.g. where an ADSE may have various health and safety duties to any worker in the vehicle, worker around the vehicle and the general public.

  – The common-law tort of negligence – e.g. where the ADSE may owe a duty of care to other road users, passengers impacted by the operation of the vehicle

  – Consumer law – e.g. where, under consumer guarantees, goods and service are required to be fit for the purpose they are intended, long-lasting etc.

  The view from some stakeholders was that these laws in combination could hold relevant parties to a high standard, so that the net impact from specific regulations is likely to be at the margins. However, the majority of stakeholders considered that existing regulatory mechanisms are not fit for purpose, and that a specialised regulator with a clear mandate and expertise in automated vehicles is required. This would avoid having to rely on a patchwork of regulation that is unlikely to comprehensively or effectively ensure in-service safety.

- The majority of submissions to the Consultation RIS suggested that without specific and nationally agreed in-service safety duties for automated vehicles, States and Territories would likely adopt a range of different approaches to addressing in-service safety issues.

  This would result in an inconsistent approach to regulating automated vehicles when they are in service. Some examples provided in consultation include:

  – Taking regulatory action under the relevant WHS laws in the jurisdiction – although it was noted that the WHS regulators in each jurisdiction may not have the expertise to take enforcement action and may also adopt different approaches to compliance and enforcement

  – Using roadworthiness or conditional registration laws to remove or restrict the operation of automated vehicles that pose a safety risk – although it was noted that this may not be ideal, given that the owners of the vehicles are potentially adversely impacted under these scenarios by not being able to access their vehicles

  – Taking enforcement action under existing State and Territory road rules – although it was noted that these laws are currently targeted at individual instances of a rule being breached, by a human driver, and the penalties are likely to be insufficient to change ADSE behaviour

  – Making reactive amendments to existing laws or introducing new laws to deal with safety issues as they emerge – an approach that is likely to result in significant differences in the regulatory approach between jurisdictions.

- A range of industry and government stakeholders agreed that a nationally inconsistent regulatory approach will impose unnecessary costs on ADSE's to comply with varying standards, which may:

  – create inefficiencies

  – act as a disincentive or barrier to enter the Australian market

  – undermine public confidence in the deployment of automated vehicle technology in Australia

  - constrain national road freight movement in the future.

- Further submissions pointed to the new in-service safety risks that the market will not eliminate or mitigate as a rationale driving the need for new regulatory frameworks, including:
  - risks of physical interference with automated vehicles, such as intentional damage
  - possible actions by users of automated vehicles that interfere with their safety; for example, attempting to defeat safety interlocks (devices which are designed to keep drivers' hands on the wheel)
  - environmental conditions, such as cyclones, hail or fog that may affect the ability of an ADS to function properly
  - poor infrastructure, algorithmic decision making (where the automated vehicle is presented with two options and is unable to decide potentially making the automated vehicle inoperable or making an unsafe decision)
  - risks associated with automated vehicles operating in mixed fleets.

3.2.3 Quantification of costs and benefits

The costs and benefits of specific regulation of automated vehicles when they are in-service, relative to what could be expected to occur under existing legal and regulatory frameworks, is determined by the impacts on safety and costs to business.

Impacts on safety

It is difficult to estimate how safe automated vehicles will be at this point in their development. It is even more difficult to estimate the extent that specific regulations can make them more or less safe and the resulting costs to governments and businesses.

It has therefore been necessary to make a number of assumptions about the costs and benefits of regulation:

- We have assumed that automated vehicles have the capacity to reduce crashes causing injury by 68 per cent. This figure is based on a study for the NSW State Insurance Regulatory Authority which states that automated vehicles will reduce:[27]
  - car driver and passenger crashes causing injury by 80 per cent
  - cyclist crashes causing injury by 70 per cent
  - motorcyclist crashes causing injury by 40 per cent
  - pedestrian crashes causing injury by 45 per cent.

  These percentages have been applied to the number of crashes causing injury per year to provide the overall weighted average, 68 per cent.[28] This estimate is more conservative than other studies, which assume that 90-95 per cent of crashes could be eliminated with the use of automated vehicles. Stakeholders were invited to provide feedback and

[27] See: https://www.sira.nsw.gov.au/resources-library/green-slip-resources/publications/scheme-reports/Finity-Report-on-Autonomous-Vehicles.pdf

[28] In the absence of specific research on the impact of automated vehicles on crashes causing fatalities, we have assumed the same relationship between the crashes causing injury and crashes causing fatality. This is may overestimate the quantum of safety benefits if the relationship is less than 1:1.

suggestions on our safety benefit assumption, but we did not receive any information that would have supported improvement of the original estimate.

Given the uncertainty around this figure, we have undertaken sensitivity testing assuming that only half of the predicted safety benefits are able to be realised i.e. a 34 per cent reduction in crashes causing injury overall.

- We have assumed that without in-service regulation only 95 per cent of the estimated safety benefits of automated vehicles are able to be realised. The reasons for this assumption include:
  - Without regulation of automated vehicles when they are in-service, the types of safety risks the NTC has identified in Chapter 2 of the Decision RIS, are not adequately addressed by existing laws and regulations
  - When safety issues do occur involving automated vehicles, they are less likely to be addressed at the system-wide level
  - In the absence of a dedicated agency responsible for proactively managing the safety of automated vehicles, government actions (e.g. recalls or restrictions) would also be more likely to occur following a major incident, like a fatality, rather than when a safety issue first arises

  The assumption that regulations could contribute 5 per cent of the overall safety benefits of automated vehicles has been developed from qualitative assessment of stakeholder feedback, rather than a specific, empirical basis. We sought feedback on the reasonableness of the figure used in the Consultation RIS but did not receive any information that would support improvement of the original estimate.

- A matter further complicating the estimation of safety benefits is the different risk approaches of manufacturers. The technology companies developing ADSs may not have the same level of vehicle safety experience as more established automotive manufacturers.

The tables below seek to quantify the potential safety impacts that the regulation of automated vehicles may have by looking at fatalities and hospitalisations from vehicle crashes and applying a number of assumptions, as explained above and below.

Table 4: Estimation of annual safety outcomes with/without specific regulation to address in-service safety risks[29]

Calculation of safety impacts	Without in-service regulation	With in-service regulation
Fatalities		
Current road fatalities per 100,000 people[1]	4.98	4.98
Estimated % reduction in fatalities due to introduction of AVs[2]	68%	68%
% of benefits realised	95%	100%
Estimated future fatalities per 100,000 people (with AVs)	1.67	1.59
Total future fatalities (with AVs)	417	397
Future reduction in fatalities due to regulation		**21**

[29] The calculations in this table focus on the differences is safety outcomes between the options, which is a small proportion of the overall safety outcomes that automated vehicles are expected to provide (see section 2.4.3). The method used to calculate these benefits is different to method used to calculate safety benefits as a component of the overall benefits for the purposes of estimating delay-costs (see section 3.6). However, to ensure there is no double counting of safety benefits, we have been conservative in our estimation of delay costs (halving the values suggested by a range of Australian and international studies). this assumption is not material enough to affect the ranking of the options.

Calculation of safety impacts	Without in-service regulation	With in-service regulation
Hospitalisations		
Current hospitalisations per 100,000 people	155.7	155.7
% reduction due to AVs	68%	68%
% of benefits realised	95%	100%
Estimated future hospitalisations per 100,000 people (with AVs)	52.2	49.6
Future hospitalisations (with AVs)	13,050	12,397
Future reduction in hospitalisations due to regulation		**652**

Source: (1) BITRE (2018), Road Trauma Australia 2017 statistical summary and (2) Finity Consulting, 2016. The impact of autonomous vehicles on CTP insurance and its regulation

- It is estimated that the cost of each fatality from road crashes is $4.33 million and each hospitalisation is $0.22 million. This is based on a combination of the direct costs associated with each event and an assessment of the willingness to pay to avoid these events, which has been calculated using revealed preference techniques.[30]

- By multiplying the assumptions about the number of avoidable fatalities and hospitalisations with the monetary values of each incident, it has been estimated that the overall value of improved safety could be in the order of $234.5 million per annum – noting that this is assuming that vehicles with automation of level 3 or higher are fully implemented at this time, which could be some decades away.

The annual value of improved safety resulting from specific regulation, and the underpinning assumptions, is shown in Table 5 below.

Table 5: Potential value of regulations to safety outcomes

Calculation of the value of safety impacts	Fatalities	Hospitalisations
Number of avoidable incidents per annum	21	652
Cost per incident (millions)	$4.33	$0.22
Value of safety benefits of improved regulations (millions)	**$91**	**$143.4**
Total (millions)	**$234.5**	

Costs to business of regulation

In the consultations with businesses during the development of the Consultation RIS, businesses considered that regulation may not impose any additional costs beyond what they would incur in the ordinary course of ensuring their vehicles operate safely. In line with this feedback, the CBA has not assumed there would be any direct costs to business as a result of regulation.

Some of the industry submissions to the Consultation RIS, however, note that whether or not regulation imposes any additional costs would depend on the type of regulatory approach. They raised some concerns about the potential for a prescriptive regulatory approach to increase their costs. This issue is discussed in more detail in section 3.3.2.

Industry stakeholders did raise concerns with two key issues that might drive high compliance costs associated under a future regulatory regime. They were:

[30] See: https://www.aaa.asn.au/wp-content/uploads/2018/03/AAA-ECON_Cost-of-road-trauma-summary-report_Sep-2017.pdf

- Inconsistencies with international regulations
- National inconsistency, either in:
  - Regulatory requirements between the States and Territories, or
  - Compliance and enforcement approaches

Feedback from stakeholders was that ADSEs would be less likely to supply the Australian market (or the market of an individual State or Territory) if their regulatory requirements exceeded or were inconsistent with international standards. There was a preference from stakeholders for Australia to be closely aligned to international regulatory approaches.

Costs to business of national inconsistency: One vehicle manufacturer was able to provide an example of the costs of inconsistency in regulatory approaches to their business. They estimated they would need around double the resources in their regulatory team if Australia adopted eight different regulatory approaches to regulating automated vehicles in-service, with eight different regulators. Extrapolating out these costs suggests the annual cost of inconsistency to business would be around $11.9 million per year. This is based on the following assumptions:

- Another three regulatory affairs associates are required per business if there are eight different State and Territory regulators. The cost of a regulatory affairs manager is $111,540[31] and a regulatory affairs associate is $75,490, with on-costs of 75 per cent (these include salary-related on costs such as superannuation leave, pay-roll taxes etc. as well as overheads such as rent, telephone and IT equipment.)[32]
- There will be between 20 and 40 companies operating or selling automated vehicles in the Australian market. There are currently about 20 car manufacturers in the Australian market.[33] There are around 20 to 46 companies that are currently developing automated vehicles.[34]

The calculation and assumptions driving the annual cost of inconsistency to business is shown in Table 6 below.

Table 6: Potential administrative compliance costs due to inconsistent regulation

Calculation of compliance costs	With a national approach	Without a national approach
Team structure		
Regulatory affairs manager	1	1
Regulatory affairs associate	3	6
Total team size	4	7
Cost of team ($)		
Regulatory affairs manager	$111,540	$111,540
Regulatory affairs associate	$75,497	$75,497
Employment related on-costs	75%	75%
Total costs per company ($m)	**$0.59**	**$0.99**

[31] One regulatory affairs manager will be required with either a national or several State and Territory based regulators

[32] See: https://www.pmc.gov.au/sites/default/files/publications/regulatory-burden-measurement-framework.pdf

[33] See: https://www.caradvice.com.au/682259/vfacts-august-2018-new-vehicle-sales/

[34] See: https://www.cbinsights.com/research/autonomous-driverless-vehicles-corporations-list/

Calculation of compliance costs	With a national approach	Without a national approach
Number of brands in the Australian Market		
Low assumption	20	20
High assumption	40	40
Total costs (low assumption) ($ million)	$11.83	$19.76
Total costs (high assumption) ($ million)	$23.66	$39.52
Mid-point of costs ($ million)	**$17.75**	**$29.64**
Additional costs of inconsistency ($ million)	**$11.89**	

Conclusion

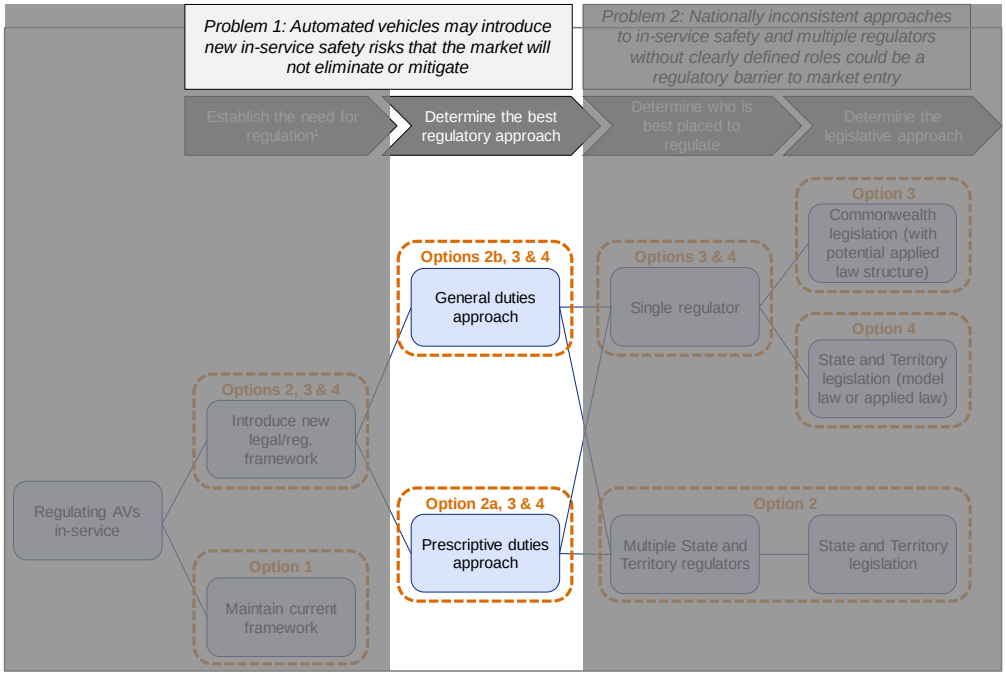
There are significant safety benefits that could be achieved from the regulation of automated vehicles when they are in-service, relative to a base case of no regulation. In addition, a national regulatory approach is likely to be less costly for businesses than States and Territories adopting different approaches.

3.3 Determining the regulatory approach

This section analyses the costs and benefits of a prescriptive regulatory approach versus an approach involving a general safety duty.

In the previous section we established the need for regulation; this section looks at the form that regulation could take, in particular the development of prescriptive or general duties.

Figure 9: Determining the regulatory approach



3.3.1 Overview of the issues

The section considers the costs and benefits of applying duties to ADSEs and their executive officers under one of two broad regulatory approaches:

- **Prescriptive duties:** under this approach, the regulated parties would be subject to new prescriptive safety duties to manage in-service safety. The duties will be enforced by a regulator. They have not yet been developed or agreed but they could relate to:
  - Cyber security failures
  - Failure to issue software updates
  - Poor quality control of software updates
  - Vehicle repairs impacting the operation of ADSs
  - Systemic safety issues.
- **A general safety duty:** under this approach, the regulated parties would be subject to a new general safety duty, requiring duty holders to take reasonable and practicable steps to ensure the safety of automated vehicles. A general safety duty may be supported by some more prescriptive rules.

  Note that under this approach there would still be a number of prescriptive duties supporting the general safety duty. The important distinction is that this option would have only a select few safety duties to support a general safety duty.

Prescriptive safety duties

Prescriptive duties are rules or statements that specify in precise terms what is required. Often, the underlying aim of a highly detailed prescriptive provision is to put clear and detailed duties on corporations or individuals to ensure safety. Road rules are an example of prescriptive duties.

Prescriptive duties are effective where there is an agreed or widely accepted standard for achieving a safety outcome and the rule is unlikely to require changing. However, they tend to remove flexibility for parties to comply in potentially more efficient ways and therefore may have high administrative and compliance costs. They also do not keep up well with rapid changes in technology and may become obsolete or require frequent adjustments, increasing the cost and complexities of compliance.

A general safety duty

Under a general safety duty, the regulated parties would need to ensure safe operation of the automated vehicle, so far as is reasonably practicable. The notion of what is reasonably practicable comes from a legislative qualification that is well known to the law and found in a number of statutes both in Australia and overseas. It is based on a legal concept called the 'standard of knowledge' in an industry. This can be determined by reference to guidelines, industry codes or in some cases, other evidence presented to a court (e.g. evidence of a pattern of failures or how other organisations have addressed problems).

It requires weighing the risk against the resources needed to eliminate or reduce the risk. It does not require every possible measure to be implemented to eliminate or reduce risk, but it places the onus on the person holding the duty to demonstrate (or be in a position to demonstrate) that the cost of additional measures to control the risk (over and above those risk controls already in place) would be grossly disproportionate to the benefit of the risk reduction associated with the implementation of the additional risk control.

General safety duties are typically preferred in environments where there is significant uncertainty. They are an outcome-focused, risk-based approach to regulation that it is not prescriptive, is flexible enough to address changes in circumstances, technology and risk factors. General safety duties are currently used in Australia in work health and safety and in transport and hence would already apply to most, if not all, aspects of automated vehicle operations.

The Productivity Commission identifies a general safety duty as the ideal regulatory approach for automated vehicles in their 2019 draft report on National Transport Regulatory Reform. Specifically, their Recommendation 8.3 states "The Australian Government should impose a general safety duty on all parties with a significant influence over the safe operation of autonomous transport technologies".[35]

3.3.2 Feedback from stakeholders

In consultations with a range of government and non-government stakeholders throughout the Consultation RIS process, the following observations have been made in relation to a general safety duty:

- Government stakeholders were broadly supportive of using a general safety duty:
  - It can be used to address the types of problems identified in Chapter 2 of the Decision RIS
  - It is flexible enough to be used to address a range of problems that may eventuate with automated vehicle safety – both anticipated and unanticipated
  - It also has the flexibility to be used over time, without the need to update legislation, as automated vehicle technology and the state of knowledge in the industry develops
  - The nature of the risks posed by automated vehicles are more likely to be at the system level (e.g. a recurring problem with an ADS causes many vehicles to frequently run red lights), rather than one-off (e.g. inattention of a single driver causes a single vehicle to run a red light on one occasion) – and general duties are more suited to managing these types of issues than prescriptive duties.
- There wasn't a consensus from business and industry stakeholders on the use of a general safety duty. Stakeholders who did not support a general safety duty generally did not support any new regulation due to the potential for it to create inconsistencies with the regulatory approaches adopted overseas.
- Others noted that a nationally applied general duty was preferable to an approach where each State and Territory adopted its own regulatory approach.
- Some industry stakeholders noted that the types of actions a business would need to take if a general safety duty applied were no different to what they would expect to do as part of their normal operations.
  - This CBA takes the view that this may be true of some businesses, but would not necessarily be true for all. We don't know how compliant or safety-focussed the automated vehicle sector will be, but the general duty is expected to encourage the sector to take proactive steps to ensure the safety of automated vehicles. It will also enable a regulator to take action if they don't.
  - Further, this feedback points to the conclusion that a general safety duty would not increase regulatory burden on business.

Feedback from a range of government and non-government stakeholders, the following observations have been made in relation to prescriptive duties:

- Government stakeholders were not supportive of primarily relying on prescriptive regulations:

[35] Productivity Commission (2019), National Transport Regulatory Reform Draft Report

  - The nature of the risks of automated vehicles are not well enough known by governments to develop prescriptive requirements
  - In a dynamic sector, such as automated vehicles, it is likely that prescriptive requirements would need to be frequently updated as technology changes

- Generally, business stakeholders were not supportive of the use of prescriptive duties:
  - This approach is seen as being more likely to create inconsistencies with the regulatory approaches adopted overseas
  - This approach is seen as being more likely to increase costs, as over time, prescriptive duties may not provide for businesses to achieve the intended safety outcomes in the most efficient way
  - There is a lack of acceptance of the need for duties of this nature at this time.

3.3.3 Quantification of costs and benefits

The relative costs and benefits of a general versus prescriptive duties-based approach is determined by the impacts on safety and costs to business.

Impacts on safety

For the purposes of distinguishing between the options, the tables below seek to quantify the potential safety impacts of either a prescriptive regulatory approach or one that includes a general safety duty, by looking at fatalities and hospitalisations from road crashes and applying a number of assumptions.

- The assumptions about the effectiveness of a general safety duty are drawn from Chapter 5 of the Decision RIS. Consistent with this analysis, it has been assumed that, relative to prescriptive duties, a general duty safety duty best provides for safety, by:
  - requiring the ADSE to take necessary steps if deficiencies in the ADS become apparent, for example, ensuring that software updates are provided
  - providing a 'catch all' in the event safety risks not captured by the self-certification criteria are discovered later, perhaps as a result of rapid advancements in ADS technology
  - encouraging duty holders to take proactive measures to detect and address safety concerns before they result in harm. A general safety duty is expected to encourage duty holders to focus more on outcomes, rather than on compliance with prescriptive rules
  - including the potential for a learning loop or feedback mechanism from incidents, the prevention of further safety risks and taking action immediately, and the promotion of a safety culture within the organisation
  - the proposed general duty will require duty holders to take ‘reasonably practicable’ steps to ensure vehicles operate safely. In a fast-changing technology environment, what isn’t reasonably practicable today, may become so in a few years’ time, as technology develops. With the general duty, the regulatory framework is flexible enough to adapt to this, whereas prescriptive requirements may become out of date and ineffective
  - encouraging comprehensive testing of products and services coming to market and reducing safety risks associated with the commercial pressure to launch a product and/or service to keep up with competitors if they are losing market share or market capitalisation

  - ensuring the ADSE remains responsible for controlling risks within its domain

- In quantifying the impacts of these approaches, it has been assumed that a general duty would be effective in controlling **known risks**, like the ones the NTC has identified in Chapter 2 of the Decision RIS, as well as **unknown risks** – those that are likely to emerge over time. A prescriptive duty approach is only likely to be effective at controlling the known risks.

- In the previous section, we assumed that without regulation, 95 per cent of the safety benefits of automated vehicles could be realised. We don't know what the split between known and unknown risks will be for automated vehicles, but in order to distinguish between the options, we have assumed that 50 per cent of risks are known and 50 per cent are unknown, meaning prescriptive regulation would address around half the safety risks of a general safety duty.[36]

- Other assumptions in the tables below are consistent with the approach outlined in the previous section.

Table 7: Estimation of safety outcomes with prescriptive regulation or a general safety duty regulation

Calculation of safety impacts	No regulation	Prescriptive regulation	A general safety duty
Fatalities			
Current road fatalities per 100,000 people	4.98	4.98	4.98
Estimated % reduction in fatalities due to introduction of AVs	68%	68%	68%
% of benefits realised	95.0%	97.5%	100%
Estimated future fatalities per 100,000 people (with AVs)	1.67	1.63	1.59
Total future fatalities (with AVs)	417	407	397
Reduction in fatalities relative to no regulation		**11**	**21**
Hospitalisations			
Current hospitalisations per 100,000 people	155.7	155.7	155.7
% reduction due to AVs	68%	68%	68%
% of benefits realised	95.0%	97.5%	100%
Estimated future hospitalisations per 100,000 people (with AVs)	52.2	50.8	49.6
Future hospitalisations (with AVs)	13,050	12,715	12,397
Reduction in hospitalisations relative to no regulation		**335**	**652**

[36] Our assumption for the percentage improvement in safety outcomes stemming from a general duties approach, as opposed to a prescriptive duties approach, is informed by the recent experience that introducing a general safety duty has had in Australian Work Health and Safety (WHS) regulation. The *2011 Work Health and Safety Act* enforced a general duty on a person conducting a business or undertaking to ensure, so far as is reasonably practicable, the health and safety of workers at the workplace. This was implemented in the States and Territories, which agreed to the model law by 2013. Since then, the worker fatality rate has decreased by 25 per cent (from approximately 2.0 per 100,000 workers in 2012 to 1.5 per 100,000 workers in 2017). It is impossible to apportion all of these benefits to the general safety duty, but in a CBA where there is limited evidence, it is informative about the benefits of a general duty approach to safety regulation.

The percentage improvement in safety outcomes from a general duties approach in the case of automated vehicles is assumed to be greater than it was in the case of WHS regulation because a) there is a higher level of uncertainty regarding the future of automated vehicles and the likely safety impacts, hence a general duty is likely to deliver even more benefits than a prescriptive approach, and b) not all States and Territories adopted the WHS model law, meaning national adoption of a general duty for automated vehicles will have an even greater positive impact. This has been reflected in the CBA by assuming prescriptive regulation would address around half the safety risks of a general safety duty.

As per the approach described in the previous section, the table below estimates the relative difference between the safety outcomes for prescriptive regulations and an approach using a general safety duty.

Table 8: Potential value of regulations to safety outcomes, prescriptive regulations and a general safety duty

Calculation of the value of safety impacts	Fatalities	Hospitalisations
Prescriptive regulations		
Number of avoidable incidents per annum	11	335
Cost per incident (millions)	$4.33	$0.22
Potential safety benefits of improved regulations (millions)	**$47.6**	**$73.7**
Total annual safety benefits of prescriptive regulations (millions)	**$121.3**	
A general duty-based regulation		
Number of avoidable incidents per annum	21	652
Cost per incident (millions)	$4.33	$0.22
Value of safety benefits of improved regulations (millions)	**$91.0**	**$143.4**
Total annual safety benefits of a general safety duty (millions)	**$234.5**	

Costs to business

Overall, some of the businesses we consulted with anticipated there might be some additional costs associated with prescriptive regulations, as these would probably give businesses less flexibility in how they comply with any regulations.

Industry stakeholders also highlighted that some inconsistency with international regulatory approaches may occur over time under a prescriptive duties approach if the prescribed duties don't keep up with international approaches. Conversely, international inconsistency was seen as being extremely unlikely under a general duties approach as, to comply with a general safety duty, businesses would be implicitly required to keep up with international best practice.

Stakeholders noted that the types of actions a business would need to take if a general safety duty applied were no different to what they would expect to do as part of their normal operations. This suggests that a general safety duty would not increase regulatory burden or cost to business.

Due to the diverging viewpoints and lack of information available to quantify the additional costs to business that would result from a prescriptive regulatory approach compared to an approach using a general safety duty, these costs are assumed zero.

The NTC provided some examples of prescriptive duties that may be considered for regulating automated vehicles in service in Appendix B of the Consultation RIS, to help inform stakeholders' estimations of costs.

Costs to government

There may be some differences to governments' costs of regulating under a prescriptive or general duties approach. In some cases, the use of a general duties approach might be more costly for the regulator if the regulator deems it necessary to develop guidance materials for industry on what is 'reasonably practicable'. Compliance and enforcement actions could also be more expensive and resource intensive under a general duties approach, as it may be more complex for the regulator to demonstrate to a court that a party should have taken

reasonable and practicable steps, rather than the often more straightforward task of demonstrating non-compliance with a prescriptive requirement.

Conversely, it could potentially be more resource-intensive for a regulator to take enforcement action for breaches of many prescriptive provisions on a case-by-case basis, even if it may be simpler to demonstrate non-compliance with each separate provision. It is also possible that prescriptive rules could lead to a regulator being more intrusive and conducting regular inspections for non-compliance. Similarly, maintaining prescriptive rules is likely to cost more than a general duties approach because more amendments are required to cover any new risks – these effects could be magnified if amendments are made across each State and Territory. These impacts would make a prescriptive duties approach relatively more expensive.

At this point in time, there isn't enough information to quantify and cost these differences, as we don't know what functions a future regulator would take, how they would approach their role or the future level of non-compliance in the sector.

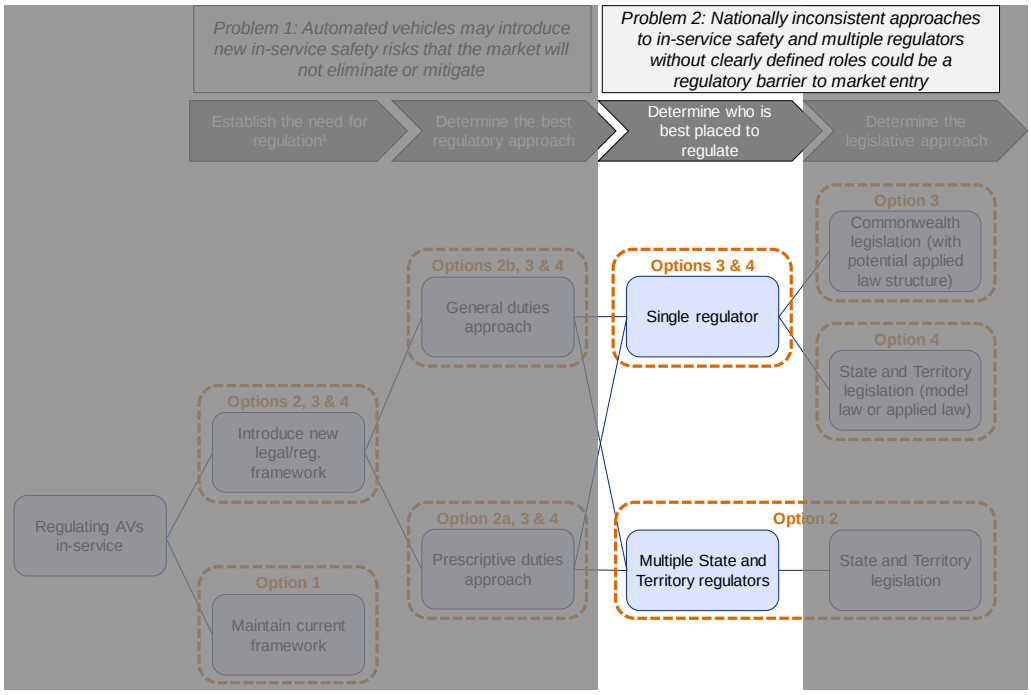
Conclusion

Although it is difficult to fully quantify the relative benefits and costs of a prescriptive regulatory approach, compared to one that uses general safety duties, it is likely that a general safety duty supported by some more prescriptive rules will provide better outcomes in terms of safety. General safety duties are also less likely to result in unnecessary costs to businesses than prescriptive duties.

3.4 Determining who should regulate

This section analyses the costs and benefits of a single, national in-service safety regulator of automated vehicles versus State and Territory-based regulators.

Figure 10: Determining who should regulate



3.4.1 Overview of the issue

A regulatory body would be required to administer any new in-service safety duties and obligations placed on parties. This body or bodies will be the regulator for the in-service safety of automated vehicles. The Decision RIS considers options involving:

- **A single national regulator** – either a new regulator or an extension of the role of an existing regulator
- **Multiple regulators** – individual States and Territories having their own regulator - either a new regulator or as an extension of the role of an existing regulator in the States and Territories.

Chapter 7 of the Decision RIS sets out some assumptions about the powers, functions and operation of a future in-service regulator for automated vehicles. The NTC has identified that the regulator's key function will be to ensure relevant parties assure the safety of an ADS over its full lifecycle. This may require it to undertake a broad range of both proactive and reactive functions, including:

- Monitoring compliance
- Investigating suspected non-compliance
- Undertaking enforcement actions
- Risk identification / intelligence
- Developing and disseminating standards

The exact functions of the regulator would depend on the regulatory approach that is adopted and the powers the regulator is given, neither of which has been determined at this stage.

3.4.2 Feedback from stakeholders

In consultations and feedback provided on the Consultation RIS, stakeholders provided feedback on the regulatory model in terms of the cost to establish and operate the regulator, and the extent that the regulator model will deliver national consistency.

Costs to establish and operate the regulator

Government stakeholders noted that it was difficult to estimate the cost of a regulator given the regulatory approach had not been set, and the considerable uncertainties about the tasks the regulator would need to undertake and the future nature of the automated vehicle industry it would be responsible for regulating.

Stakeholders provided a number of examples of existing regulators that might undertake similar functions. These are discussed in the section below and have been used to calculate some indicative costs for a single national regulator and multiple regulators.

Level of national consistency

As noted in section 2.5.2, the two key issues that stakeholders identified as driving compliance costs associated with regulations were:

- Inconsistencies with international requirements
- National inconsistency, either in:
  - Regulatory requirements between the States and Territories, or
  - Compliance and enforcement approaches.

Even where the laws are consistent across State and Territory jurisdictions, there are often different regulatory approaches where there are different regulators. This is expected to increase costs for businesses in dealing with eight State and Territory based regulators, rather than a single national regulator.

Based on the companies that are currently developing automated vehicles, it is assumed that most ADSEs will be large international companies and will operate across all States and Territories, meaning they would potentially need to interact with eight State and Territory based regulators on safety issues, which in most cases, would have national implications.

3.4.3 Quantification of costs and benefits

There are costs and benefits to both government and business inherent in the difference between having a single, national regulator and several State and Territory based regulators. We have looked at a range of different regulators and considered their costs in considering the costs and benefits of the different regulator options.

The regulators we have considered are drawn from the transport sector as well as other regulators, who might have comparable functions or a similar scale to a future regulator of in-service automated vehicles. The annual operating costs and total staff of each regulator are shown in Table 9.

Table 9: Examples of other regulators and their costs

Example regulators	Annual costs $m	Staff
Transport regulators		
Australian Maritime Safety Authority (AMSA)	$201.3	407
Australian Transport Safety Bureau (ATSB)	$24.7	107
Civil Aviation Safety Authority (CASA)	$179.9	832
National Heavy Vehicle Regulator (NHVR)	$149.2	272
Office of the National Rail Safety Regulator (ONRSR)	$36.7	143
Average	**$118.4**	**352**
Other potential comparator regulators		
Food Standards Australia New Zealand (FSANZ)	$19.7	108
National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)	$31.7	112
National Industrial Chemicals Notification and Assessment Scheme (NICNAS)	$16.4	N/A
Average	**$22.6**	**110**
Average of smaller regulators (i.e. excl. AMSA, CASA, NHVR)	**$25.9**	**118**

Sources: Annual reports of the listed regulators, figures are for 2017-18

Estimated cost to government of a national regulator

The timing and nature of the roll-out of automated vehicles will influence the size of the regulatory task, but we don't know how that roll-out will occur. Chapter 7 of the Decision RIS discusses the implications for the size of the regulatory task. Overall, it seems likely that a future regulator would be more likely to require a similar level of resource to some of the smaller regulators listed in the table above (i.e. excluding AMSA, CASA and NHVR), at least initially. This is because most of its functions will relate to a limited number of parties (i.e. 20-40 ADSEs and their executive officers), with potential for some additional regulatory effort focussed on repairers. It is also likely to undertake a similar breadth of activities to these regulators – at least based on what could be assumed at this time.

The average annual cost of these regulators is around **$25 million per year**[37] **and another 50% of annual costs could be assumed for set-up costs** – noting these figures are indicative only. They would need to be re-estimated once the regulatory approach is agreed and the powers and functions of the regulator are more closely considered.

The NTC has not yet considered who would meet the costs of a future regulator for automated vehicles, so it is not included in the CBA. However, the costs of a future regulator for automated vehicles will likely ultimately be borne by industry and/or taxpayers.

Estimated cost to business of a national regulator

The cost to business of a single regulator is assumed to be zero as this allows for the analysis to focus on the incremental cost of dealing with several State and Territory based regulators.

[37] This figure has been informed by the budgets of the other regulators described in Table 9 – but is indicative only.

Estimated cost to government of State and Territory regulators

There would be eight different regulators under the option of States and Territories undertaking the in-service regulation of automated vehicles. This option is likely to be considerably less efficient than a single, national regulator for the following reasons:

- Overheads would be larger for the eight regulators than for a single regulator
- There would be duplications in otherwise-scalable functions, like policy development

There would be overlaps in many of the compliance and enforcement functions undertaken, as most of the ADSEs will be operating nationally, meaning if compliance or enforcement action is needed in one jurisdiction, it is likely it would also be needed in other jurisdictions. However, feedback from Government stakeholders is that State and Territory based regulators are unlikely to cost eight times the cost of a national regulator. Firstly, States and Territories would be unlikely to dedicate the same level of resources to the task (particularly smaller jurisdictions). Secondly, based on the feedback of some jurisdictions, it is likely that some jurisdictions would economise by extending the functions of their existing road transport agencies, public road managers and enforcement agencies (at least initially) to also include automated vehicles.

Overall, the assumption applied in the modelling is that State and Territory-based regulators would cost about twice as much as a national regulator, or around **$50 million per year**, as well as one-off establishment costs, which are assumed to be equivalent to 50 per cent of annual costs (i.e. **$25 million**).

Estimated cost to business of State and Territory based regulators

Industry stakeholders have raised concerns about additional costs associated with national inconsistency, including from having multiple regulators with a range of different regulatory approaches. An ADSE operating nationally may be faced with contradictory requirements from different jurisdictions, making it nearly impossible to comply with requirements in each State and Territory. The estimated incremental cost of this inconsistency was set out in Table 6 and is approximately **$12 million per year**.

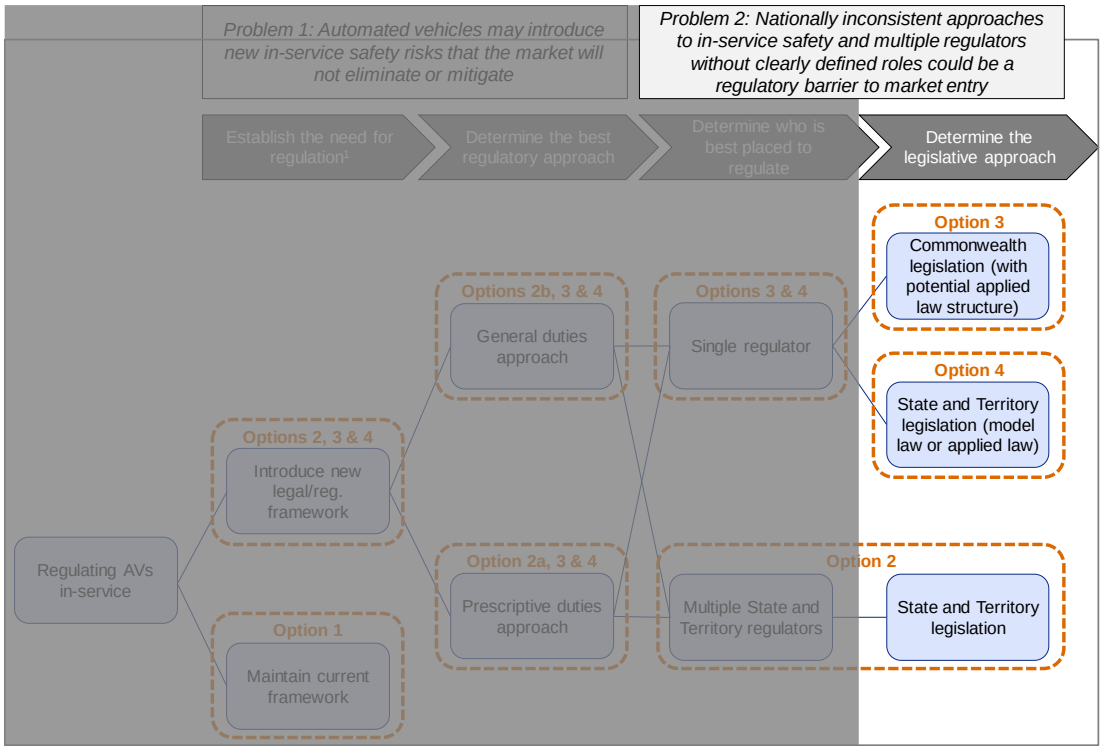
Conclusion

Based on the analysis above, it is anticipated that State and Territory-based regulators for the in-service safety of automated vehicles would be more expensive for governments to operate than a single, national regulator. Using multiple State and Territory-based regulators is also likely to result in additional costs to businesses, as well as lead to greater inconsistency in the regulatory approaches between the jurisdictions.

3.5 Determining the legislative approach

This section analyses the costs and benefits of three different legislative approaches: (1) based on model laws that are adopted by the States and Territories, (2) based on a Commonwealth law and (3) based on a State law that is applied in other States and Territories.

Figure 11: Determining the legislative approach



3.5.1 Overview of the issue

The NTC has included three options for the legislative approach to applying duties to automated vehicles when they are in-service. They are:

- **Model law:** model law would set out the model safety duties and powers for the regulators. It is likely the NTC would be responsible for developing the model law, and it would need to be agreed with States and Territories. The model law itself would have no legal effect. Each State or Territory would need to introduce new legislation based on the content of the model law to implement the safety duties and powers in their jurisdiction.

- **Commonwealth law**: the Commonwealth Parliament would make a national law for the in-service safety of automated vehicles. Under this option, each State and Territory would be required to cover any 'gaps' created by constitutional limits of Commonwealth legislative power.

- **State or Territory applied law:** a 'host' State or Territory legislature would introduce a law for the in-service safety of automated vehicles. This law would be agreed by all States and Territories. Once the host State or Territory's law was in place, the 'participating' States and Territories would legislate so that the law of the host state applied in their jurisdiction

Chapters 8 and 9 of the Decision RIS describe these approaches in more detail.

3.5.2 Feedback from consultations

In the consultations for the CBA, the feedback on the different approaches focussed on the extent that each option was likely to deliver a nationally consistent approach to regulating automated vehicles when they are in-service.

Overall, stakeholders raised concerns about the capacity of any of the options to deliver complete national consistency. Stakeholders concerns included:

- States and Territories being likely to introduce significant variations to either a model law or a state-based applied law. Stakeholders cited examples of other 'national laws', where States and Territories had been unable to agree to a fully national approach.

- In the case of model laws, inconsistencies could arise from States and Territories being slow in passing amendments to the laws, resulting in different laws applying in different States and Territories.

Although there was no clear consensus from stakeholders about which option would be most likely to deliver a nationally consistent approach, the majority of feedback suggested that Commonwealth law (as per Option 3) was less likely to lead to inconsistency between jurisdictions and delay in the uptake of automated vehicles, followed by State and Territory applied law (Option 4) and finally model law (Options 2a and 2b). These issues are discussed in greater detail below.

3.5.3 Quantification of costs and benefits

There are potentially some differences in the costs and benefits of the proposed approaches. These relate to the degree that the options provide for national consistency, the costs of updating and maintaining laws and also the speed of automated vehicle rollout.

Degree to which legislative implementation approaches provide for national consistency

The NTC's Decision RIS draws the following conclusions regarding consistency of legislative implementation approaches:

- The least consistent approach would be through using existing frameworks, as they fail to provide clear and consistent legal duties for ADSEs and others with a role in in-service safety.

- Model laws risk inconsistent regulatory approaches and safety outcomes between States and Territories if States and Territories introduce significant variation when implementing the model law, or do not introduce regulation at all.

- Commonwealth law is likely to result in greater national consistency than State and Territory applied law.[38] This is because States and Territories have greater flexibility when applying the law of a host State or Territory, compared to when they fill the 'gaps' left in a Commonwealth law. Applied law creates the potential for derogation among the States and Territories.

Overall, a greater level of consistency is provided by Commonwealth Law as it utilises federal court (i.e. one single court system). In contrast, State and Territory applied law involves multiple court systems and risk inherent inconsistency.

[38] This assumes that all states and territories will apply the host state or territory's law consistently.

The tables below provide an indicative assessment of the degree that each approach for legislation would provide for national consistency, and the relative cost implications.

Table 10: Assessment of legislative options by the level of national consistency they provide

Legislative approach	Consistency of laws	Consistency of updates
No national approach	○	○
Model laws	◑	◑
Commonwealth Law	●	●
State or Territory applied law	◕	◕

Legend ○ Least consistent ● Most consistent

Previous analysis of the National Heavy Vehicle Registration Scheme assessed the quantitative difference in the cost of a single, national system relative to a scheme delivered through jurisdictional systems. This analysis suggests that a national system leads to additional avoided costs of 16 per cent relative to a jurisdictional-based system which delivers a 5 per cent improvement, and model laws which deliver a 1 per cent improvement.[39]

These percentage reductions have been applied to the costs incurred by business and government from the different regulatory approaches in Options 3 and 4. This approach provides an indication of the potential difference in relative benefits from the legislative approach between the options. The results are outlined in Table 11.

Table 11: Benefit to business and government from each legislative approach

Consistency of the regulatory approach	Option 1	Option 2a	Option 2b	Option 3	Option 4
	$millions	$millions	$millions	$millions	$millions
20-year NPV					
Direct benefit to business	$0.0	$0.4	$0.4	$6.6	$2.1
Direct benefit to government	$0.0	$1.0	$1.0	$15.2	$4.8
10-year NPV					
Direct benefit to business	$0.0	$0.3	$0.3	$4.2	$1.3
Direct benefit to government	$0.0	$0.6	$0.6	$10.2	$3.2

Cost to Government of updating and maintaining laws

There may be some less significant cost savings to Government from using State-based applied laws (Option 4) or a Commonwealth law approach (Option 3), compared to model laws (Options 2a and 2b), as applied laws are often updated automatically by other jurisdictions, without the need for all State and Territory Parliaments to pass the changes to

[39] PwC analysis of the National Heavy Vehicle Registration Scheme, based on jurisdictional data and assumptions

the laws. However, these savings are minor relative to other issues considered in this CBA and so have not been quantified.

Conclusion

Based on the analysis above, it is anticipated that Commonwealth Law provides for more consistency, and therefore lower cost to business and government compared to State and Territory applied law and model law.

3.6 Costs of a delay in uptake

A major driver of the costs and benefits of the different options for regulating automated vehicles is the likelihood the options would in some way delay the uptake of those vehicles. This would result in deferral of some of the benefits that are predicted to come with the uptake of automated vehicles. Because these benefits are estimated to be so high, the cost of a delay is also high.

Our research and feedback from stakeholders suggested that the options have the potential to delay or speed-up the uptake of automated vehicles, depending on four key factors:

- Demand driven factors:
  - Safety and perceived safety
  - Consumer protection
- Supply driven factors:
  - The level of regulatory requirements
  - Inconsistent regulatory approaches.

To estimate the likelihood that an option would lead to a delay in uptake, we have assessed each option against these factors.

3.6.1 Estimated cost of a one-year delay in uptake

Using the assumptions detailed in section 2.4.3 about the overall benefits that automated vehicles may generate for the Australian economy, we have estimated the costs or benefits of a one-year delay in their uptake. The purpose of this calculation is to determine the scale of the impact of a delay in the uptake of automated vehicles, so it can be considered against other, more readily quantifiable costs.

This analysis incorporates the benefits delivered by vehicles of level 3 automation or higher, as most studies quote benefits from vehicles with a level of automation where the driver does not need to monitor the dynamic driving task nor the driving environment at all times.[40]

The first step in the calculation is to estimate the rate of uptake of automated vehicles and the rate that the predicted benefits of automated vehicles will be realised. There is uncertainty about the rate that automated vehicles will be adopted.

For the purposes of the CBA, it has been assumed that vehicles of level 3 automation or higher enter the Australian market in 2022 (in very small numbers), reaching a 2 per cent and 15 per cent uptake by 2025 and 2035 respectively. In the periods in-between, there will be consistent growth in uptake, to the extent that 30 per cent of vehicles on the road will be automated by 2039 (a 20-year time-period).

This assumption has been made with reference to the following evidence about the uptake of automated vehicles:

- There are around 15 companies currently intending to have developed level 4 and above vehicles by 2022 (see Decision RIS, Figure 1), at which point around 1 per cent of vehicles are assumed to be automated.
- Bain & Company forecasted five upcoming megatrends in the automotive industry in their recent 2019 study. They predict that around 2 per cent of the newly registered cars in Europe will be of level 4 automation by 2025. While they report that there will be a

[40] KPMG, *Connected and Autonomous Vehicles – The UK Economic Opportunity*, (2015) – United Kingdom

decrease in accident rate, they expect the new car sales to decrease substantially by 2030 in response to increasing use of driverless taxis.[41]

- A study in the US forecasted the uptake rate of automated vehicles using simulations, taking into account developments in demand and supply within the market. Notably, the forecasts predict:
  - Vehicles with conditional automation (level 3) would make up between 1.9 and 3.5 per cent of the vehicle fleet by 2020 and between 4.5 and 8.4 per cent by 2030.
  - Vehicles with high automation (level 4) would make up between 2.0 and 5.5 per cent of the vehicle fleet by 2020 and between 10.3 and 33.8 per cent by 2030.42
- A study in the Netherlands conducted simulations showing that the fleet size of level 0 and level 1 vehicles – which is currently around eight million vehicles in the Netherlands – is expected to fall relatively rapidly. By contrast, take-up of levels 4 and 5 is expected to be relatively slow, suggesting that the fleet size in 2025 could be between 1.1 million and 2.2 million for level 4.[43]
- McKinsey & Company developed predictions of new vehicle market shares for conditional and high automation for a high and low adoption scenario between 2020 and 2040. Under their high-disruption scenario for fully automated vehicles (level 4), they predict a 15 per cent up take by 2030. This is subject to progress on the related technical, infrastructure, and regulatory challenges. There will be a ramp-up between 2030 to 2039, where AV availability spreads across popular consumer models.
- KPMG conducted a study in the UK which predicted vehicles with level 3 automation would hit the market in 2017 and reach peak penetration of 88 per cent in 2028. According to their estimates, vehicles with level 4 automation would reach the market in 2024 and gradually reach 25 per cent penetration by 2030.[44]
- Deloitte's study on Autonomous Driving suggests that level 4 automated vehicles will be available commercially between 2021 and 2022. This is consistent with our estimation that the roll-out of automated vehicles in Australia will begin in 2022.[45]

The results are shown in the table and figure below.

Given the uncertainty around both the magnitude of the benefits from automated vehicles and their uptake, we have included the estimated annual benefits of only half of the predicted benefits.[46] These are still significant. By 2030, they are estimated to be $2.7 billion per year and by 2039 they are estimated to be $9.7 billion per year.

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41 Bain & Company (2019), Autonomous driving, shared mobility and the rise of electric vehicles will reshape Europe's car trade industry.

42 Bansal, P. & Kockelman, K. M., 2017. Forecasting Americans' long-term adoption of connected and autonomous vehicle technologies. Transportation Research Part A, Volume 95, pp. 49-63

43 Nieuwenhuijsen, J., 2015. Diffusion of Automated Vehicles: A quantitative method to model the diffusion of automated vehicles with system dynamics, Delft: Delft University of Technology.

44 KPMG (2015), Connected and Autonomous Vehicles – the UK Economic Opportunity

45 Deloitte (2019), Autonomous Driving, Moonshot Project with Quantum Leap from Hardware to Software & AI Focus.

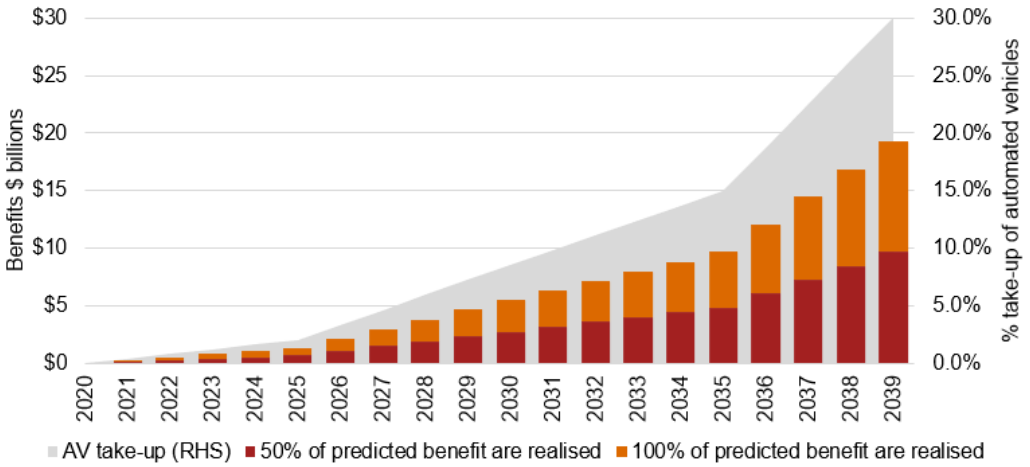
46 Halving the estimated annual benefit also acknowledges the potential for vehicles of level 3 automation to introduce additional safety risks due to the reliance of fallback ready users.

Table 12: Estimated take-up rate of automated vehicles and resulting benefits to Australian economy

Year	Automated vehicle take-up rate	Benefits to economy if 100% of predicted benefit are realised[1a]	Benefits to economy if 50% of predicted benefit are realised[1b]
	% of vehicles on the road that are automated	$ billions	$ billions
2020	0.0%	$0.00	$0.00
2021	0.4%	$0.26	$0.13
2022	0.8%	$0.51	$0.26
2023	1.2%	$0.77	$0.39
2024	1.6%	$1.03	$0.51
2025	2.0%	$1.29	$0.64
2026	3.3%	$2.12	$1.06
2027	4.6%	$2.96	$1.48
2028	5.9%	$3.79	$1.90
2029	7.2%	$4.63	$2.31
2030	8.5%	$5.47	$2.73
2031	9.8%	$6.30	$3.15
2032	11.1%	$7.14	$3.57
2033	12.4%	$7.97	$3.99
2034	13.7%	$8.81	$4.40
2035	15.0%	$9.65	$4.82
2036	18.8%	$12.06	$6.03
2037	22.5%	$14.47	$7.23
2038	26.3%	$16.88	$8.44
2039	30.0%	$19.29	$9.65

Notes: (1a and 1b) these columns are calculated by multiplying the estimated total benefit per year once automated vehicles are fully adopted ($64.28 billion) by the per cent of vehicles on the road that are automated.

Figure 12: Potential uptake of automated vehicles and associated benefits



The overall predicted benefits to the Australian economy ($64.3 billion) per year, are predicated on vehicles of level 3 automation or higher being fully adopted. In reality, it is assumed that the benefits will be progressively realised as take-up of automated vehicles occurs (e.g. when 5 per cent of vehicles are automated, 5 per cent of the full estimate of the benefits will be realised).

For the purposes of the CBA, we have estimated the cost of a one-year delay in realising these benefits – the results are shown in Table 13. Over a 10-year time horizon (2020 to 2029), this is estimated to be $3.5 billion, or $9.4 billion over 20 years (2020 to 2039). Even if only half of the benefits of automated vehicles are able to be realised, the NPV of a one-year delay in realising these benefits would be $1.8 billion over 10 years or $4.7 billion over 20 years. Due to the uncertainty about the benefits, we have chosen to only count half of the benefits in the CBA.

Table 13: Estimated benefits of automated vehicles over the next 10 and 20 years, and NPV of a one-year delay in realising these benefits

Scenario description	NPV of benefits over the next 10 years	NPV of benefits over the next 20 years	NPV of a one year delay in realising benefits 10 years	NPV of a one year delay in realising benefits 20 years
	$ billions	$ billions	$ billions	$ billions
50% of benefits are realisable	$4.54	$23.45	-$1.75	-$4.69
100% of benefits are realisable	$9.08	$46.89	-$3.50	-$9.37

Source: PwC calculations based on 2, 15 and 30 per cent uptake by 2025, 2035 and 2039 respectively and 7 per cent discount rate.

3.6.2 Estimated likelihood of a delay in uptake

This section considers the different features of the four options developed by the NTC and the likelihood they will contribute to a delay in the uptake of automated vehicles.

Safety and perceived safety

As indicated in section 2.5, individuals are likely to have higher expectations of safety for automated vehicles than they do for conventional vehicles. Any real or perceived negative safety outcomes of automated vehicles are therefore likely to have a material impact on uptake. Our assessment of the impact that regulation has on safety outcomes is driven by whether there is specific regulation and the distinction between general and prescriptive safety duties.

- **The need for regulation**: As shown earlier in Table 4, we have estimated that regulating automated vehicles in-service could result in 21 less fatalities and 652 less hospitalisations per annum (when vehicles with automations of level 3 or higher are fully adopted) compared to a scenario without effective regulation.

- **General versus prescriptive duties**: As shown earlier (see sections 3.2 and 3.3) we have estimated that a general safety duty would be more effective at managing safety risks than prescriptive duties, resulting in 10 less fatalities and 320 less hospitalisations per annum (when advanced automated vehicles are fully adopted).

Assuming consumer uptake of automated vehicles is influenced by their safety, Option 1 would therefore the most likely to result in delay in uptake. Option 2a (prescriptive duties) would be less likely to result in a delay, but Options 2b, 3 and 4 (a general safety duty) would be least likely to result in a delay.

Consumer protection and certainty

The level of consumer protection is assumed to be another driver of the uptake of automated vehicles. Uncertainty about the legal responsibilities and protections for automated vehicle users may influence individuals' willingness to adopt automated vehicle technology.

Option 1, relying on existing laws and regulations to manage automated vehicles when they are in service is likely to lead to uncertainty about the responsibilities of different parties and the levels of protection for consumers. Options 2a, 2b, 3 and 4 clarify these responsibilities by establishing regulatory duties for the parties with the most influence on safety outcomes.

The level of regulatory requirements

As indicated in section 2.5, regulatory requirements for automated vehicles in Australia when they are in-service that are different to international requirements may be a disincentive for ADSEs supplying automated vehicles to the Australian market. During consultations, feedback from industry was clear that any requirements in excess of those implemented in major world markets would be likely to deter suppliers from introducing their technology to Australia, which would result in delay in the uptake of vehicles.

Option 1 is considered to have the lowest level of regulatory requirements as it does not impose any additional regulation that is specific to automated vehicles. Stakeholders generally did not think that a general safety duty approach would lead to any substantive requirements that are in excess of what the industry would do without regulation. However, their feedback was that a prescriptive approach to regulation (Option 2a) would be more likely to result in costs, and hence more likely to be a disincentive to supplying vehicles to Australia than the current approach (Option 1) or the options that involve a general safety duty (Options 2b, 3 and 4).

Inconsistent regulatory approaches

Inconsistency in regulatory approaches across Australia is likely to add costs to business as well as be a disincentive to supplying vehicles to Australia. During consultations, industry stakeholders emphasised that separate approaches to regulation in Australia would effectively further fragment an already small (by global standards) vehicle market.

As noted previously, national inconsistency is driven by two main key factors, the regulatory requirements and the compliance and enforcement approach. The options have been assessed as follows:

- Option 1 – the least likely to provide for consistent regulatory approaches, as there is no national approach to managing in-service safety risks. Under this option it is anticipated that States and Territories would be likely to develop their own, different responses to in-service safety issues as these issues emerge.

- Options 2a and 2b – more likely to provide for national consistency due to a consistent national approach. But there may be inconsistencies in the approach to applying laws, given that States and Territories would each be responsible for regulating in-service safety risks.

- Options 3 and 4 – most likely to provide for national consistency due to a consistent national approach and a single national regulator. As described in section 3.5, the method of legislating, also affects the level of national consistency. State and Territory applied laws (Option 4) are likely to be more consistent over time than model laws (Options 2a and 2b) because they don't require all of the State and Territory parliaments to pass updates at the same time. An approach involving the use of Commonwealth laws (Option 3) might have even more consistency than State and Territory applied laws (Option 4) as it is exposed to less variation between jurisdictions.

3.6.3 Estimated impacts of delay

The table below summarises our assessment of the likelihood for each option to result in a delay in the uptake of automated vehicles based on the supply and demand factors listed above.

Delay refers to the time lag for the first introduction of automated vehicles to Australia. We have then estimated the likelihood that the options would result in a one-year delay in the

uptake of automated vehicles and the cost of this delay over 10 and 20 years, counting 100 per cent or 50 per cent of the predicted benefits associated with automated vehicles (this approach to making this estimation is explained in section 2.5).

Table 14: Assessment of the likelihood of delay for each option and the impact of a delay

	Option 1	Option 2a	Option 2b	Option 3	Option 4
Demand factors					
Safety and perceptions of safety	○	◑	●	●	●
Consumer protection and certainty	○	●	●	●	●
Supply factors					
Level of regulatory requirements	●	◑	◕	◕	◕
Consistency of the regulatory approach	○	◔	◔	●	◑
Ranking	**5**	**4**	**3**	**1**	**2**
Probability of a one-year delay in uptake	50%	30%	15%	0%	5%
Delay costs	$ billions	$ billions	$ billions	$ billions	$ billions
NPV 10 years, with 100% of benefits	-$1.8	-$1.1	-$0.5	$0.0	-$0.2
NPV 10 years, with 50% of benefits	-$0.9	-$0.5	-$0.3	$0.0	-$0.1
NPV 20 years, with 100% of benefits	-$4.7	-$2.8	-$1.4	$0.0	-$0.5
NPV 20 years, with 50% of benefits	-$2.3	-$1.4	-$0.7	$0.0	-$0.2
Legend	○ Higher likelihood of delay		● Lower likelihood of delay		

Conclusion

Based on our assessment of the supply and demand factors listed above, Option 1 would be most likely to result in a delay in uptake (50 per cent chance), followed by Option 2a (30 per cent), Option 2b (15 per cent), Option 4 (5 per cent) and finally Options 3 (no delay).

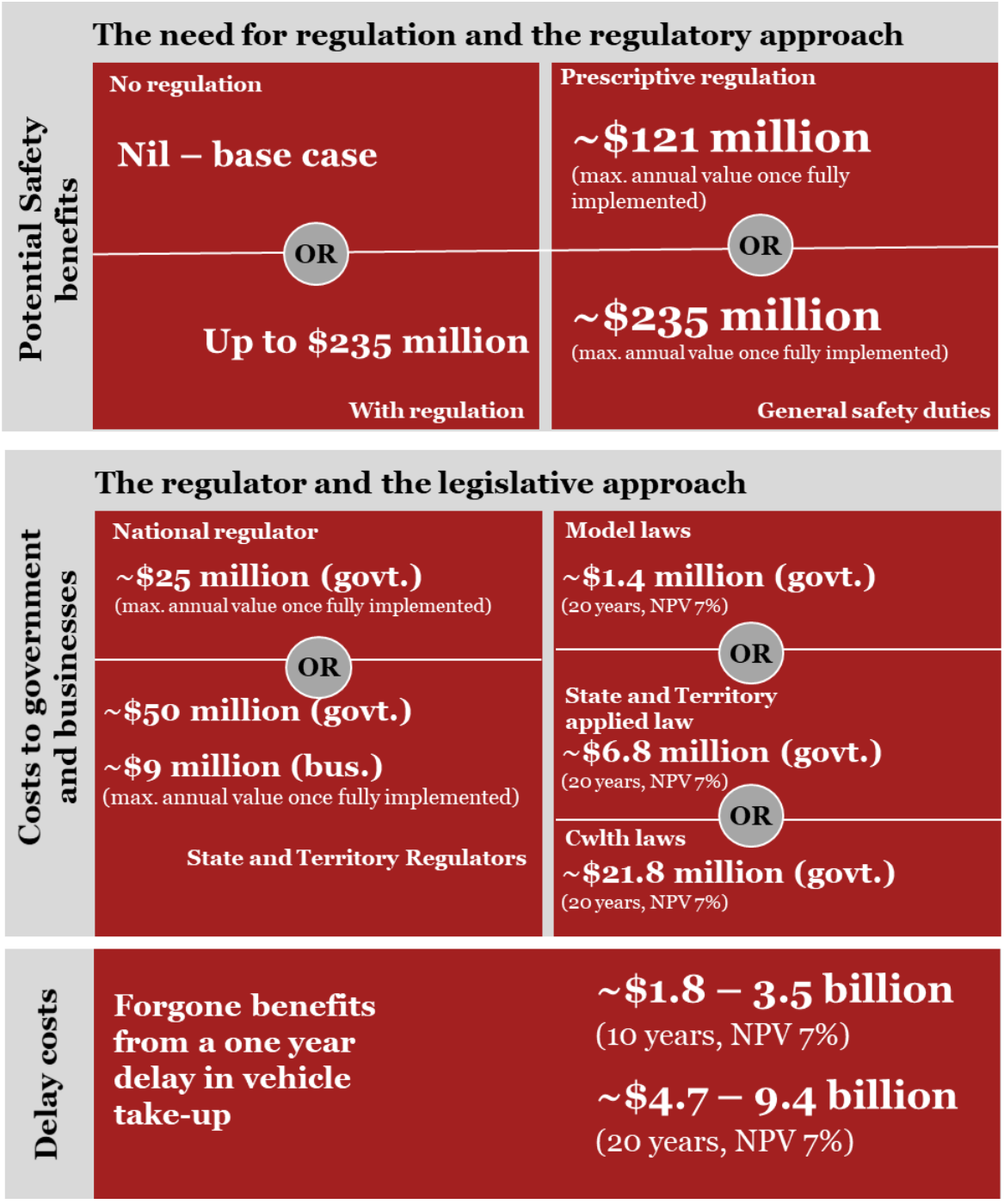
The probabilities assigned to a delay are based on our assessment of the impacts of the different options and the collective feedback from stakeholders about the issues that are likely to affect the demand for and supply of automated vehicles. These assumptions are significant in terms of the overall analysis and the ranking of the options.

3.7 Relative scale of the issues considered

Even though there is uncertainty about the figures used in the analysis, what we have been able to quantify shows the relative scale of the issues considered in the CBA. The analysis clearly shows that the potential scale of forgone benefits from a delay in the uptake of automated vehicles significantly exceeds all other costs and benefits.

The following chapter discusses the options in terms of their impact on a delay in the uptake of automated vehicles, as well as the other issues considered by the CBA.

Figure 13: Summary of the relative scale of the issues considered



Source: PwC, (1) the CBA focusses on the incremental impacts of the four regulatory options, not the overall safety benefits that automated vehicles will provide. The base case is our reference case, which use to compare the other options. Therefore, it has a safety benefit of zero.

4 Options analysis

This chapter sets out the analysis of the expected impacts of the four regulatory options.

4.1 Assessment of the options

The following section sets out the assessment of the options. It draws on the analysis presented in the earlier chapters.

4.1.1 Option 1

Option 1 predominantly provides for the in-service safety of automated vehicles through existing legislation and regulatory instruments . Under this option, there would be no new regulator or regulation for in-service safety at a National level, and no explicit in-service safety duties for ADSEs or other parties at a National level. Instead, in-service safety is managed separately by each state and territory through existing legal frameworks and some new, supporting duties at the State / Territory level.

Option 1 is the base case for the quantitative analysis of the other options. It assumed to have zero costs and benefits. The costs and benefits of the other options have been calculated in reference to this option. For clarity, the costs and benefits of Option 1 include:

- An assumption that only 95 per cent of the predicted safety benefits of automated vehicles will be able to be realised in the absence of an effective regulatory regime for managing in-service safety.
- An assumed 50 per cent chance of a one-year delay in the take-up of automated vehicles, which would cost $4.7 billion over 20 years (for the purposes of the options assessment, we have taken a conservative approach to estimating the benefits of automated vehicles and only counted half of their predicted impacts).
- Costs to businesses of approximately $11.9 million per annum as a result of having to interact with multiple State and Territory regulators.

4.1.2 Option 2a

For Option 2a, regulators in each State and Territory would manage the in-service safety of automated vehicles for key regulated parties – ADSEs and ADSE executive officers. The regulated parties will be subject to new prescriptive safety duties to manage in-service safety. Model law would set out the model safety duties and powers for the regulators.

The assessment of Option 2a is set out in the table below. Relative to Option 1, the anticipated impacts of this option are:

- Additional safety benefits of $72.2 million as a result of being able to address half of the avoidable crashes that would occur without any regulatory interventions.
- Costs to government of $561.0 million to establish and operate State and Territory based regulators.

- Cost reductions to business and government of $1.4 million from the added consistency provided by model laws.

- Additional benefits of $937.1 million as a result of being able to realise the benefits of automated vehicles sooner (relative to the base case) – mainly as a result of improved safety and the adoption of a national regulatory approach via model law. This includes the additional safety benefits that automated vehicles are expected to provide compared to conventional vehicles, but not the additional safety benefits that are assumed to come from the choice of regulatory approaches (i.e. the extra 5 per cent, which is explained in section 3.2.3).

The net impact of this option, relative to the base case, over a 20-year time-period is estimated to be $449.7 million.

Table 15: Assessment of the impacts of Option 2a

Option feature	Type of impacts	Annual impact	NPV of impact over 20 years	Description
		$ millions	$ millions	
Regulatory approach				
Prescriptive duties	Safety benefit	$186.7	$72.2	Relative to the base case, these are the additional anticipated safety benefits
Regulator				
States and Territories	Govt costs	-$50.0	-$561.0	Cost to establish and operate regulators
	Bus. costs	$0.0	$0.0	The costs to business of dealing with multiple regulators will be the same as the base case
Choice of laws				
Model laws	Bus. costs	$0.05	$0.4	Model law is assumed to provide slight improvements in consistency relative to the base case
	Govt. costs	$0.1	$1.0	
Sub-total of impacts			**-$487.4**	
Delay impacts				
Benefits of automated vehicles able to be realised sooner	Safety, productivity benefits	N/A	$937.1	Relative to the base case, this is the additional value of realising the benefits of automated vehicles sooner. Only 50% of predicted benefits of automated vehicles have been counted.
Overall impact of the option			**$449.7**	

* This is the estimated annual benefit when advanced automated vehicles are fully adopted. It is higher than the predicted benefits over 20 years because we have assumed that only 30 per cent adoption will be achieved by 2039.

4.1.4 Option 2b

For Option 2b, regulators in each State and Territory would manage the in-service safety of automated vehicles for key regulated parties – ADSEs and ADSE executive officers. The regulated parties will be subject to a new general safety duty to manage in-service safety that is supported by prescriptive duties. Model law would set out the model safety duties and powers for the regulators.

The assessment of Option 2b is set out in the table below. Relative to Option 1, the anticipated impacts of this option are:

- Additional safety benefits of $139.6 million as a result of being able to address all of the avoidable crashes that would occur without any regulatory interventions.
- Costs to government of $561.0 million to establish and operate State and Territory based regulators.
- Cost reductions to business and government of $1.4 million from the added consistency provided by model laws.
- Additional benefits of $1.6 billion as a result of being able to realise the benefits of automated vehicles sooner (relative to the base case) – mainly as a result of improved safety with a general safety duty and the adoption of a national regulatory approach via model law.

The net impact of this option, relative to the base case, over a 20-year time-period is estimated to be $1.2 billion.

Table 16: Assessment of the impacts of Option 2b

Option feature	Type of impacts	Annual impact	NPV of impact over 20 years	Description
		$ millions	$ millions	
Regulatory approach				
General safety duties	Safety benefit	$234.5*	$139.6	Relative to the base case, these are the additional anticipated safety benefits
Regulator				
States and Territories	Govt costs	-$50.0	-$561.0	Cost to establish and operate regulators
	Bus. costs	$0.0	$0.0	The costs to business of dealing with multiple regulators will be the same as the base case
Choice of laws				
Model laws	Bus. costs	$0.05	$0.4	Model law is assumed to provide slight improvements in consistency relative to the base case
	Govt. costs	$0.1	$1.0	
Sub-total of impacts			**-$420.1**	
Delay impacts				

Option feature	Type of impacts	Annual impact	NPV of impact over 20 years	Description
		$ millions	$ millions	
Benefits of automated vehicles able to be realised sooner	Safety, productivity benefits	N/A	$1,639.9	Relative to the base case, this is the additional value of realising the benefits of automated vehicles sooner. Only 50% of predicted benefits of automated vehicles have been counted.
Overall impact of the option			**$1,219.8**	

* This is the estimated annual benefit when advanced automated vehicles are fully adopted. It is higher than the predicted benefits over 20 years because we have assumed that only 30 per cent adoption will be achieved by 2039.

4.1.5 Option 3

For Option 3, there would be a single, national regulator with powers to enforce general safety duties on ADSEs and ADSE executive officers through Commonwealth law.

The assessment of Option 3 is set out in the table below. Relative to Option 1, the anticipated impacts of this option are:

- Additional safety benefits of $139.6 million as a result of being able to address all of the avoidable accidents that would occur without any regulatory interventions.
- Costs to government of $280.5 million to establish and operate a national regulator.
- Benefits to business of $115.6 million from only having to interact with one regulator.
- Cost reductions to business and government of $21.8 million from the added consistency provided by Commonwealth law.
- Additional benefits of $2.3 billion as a result of being able to realise the benefits of automated vehicles sooner (relative to the base case) – mainly as a result of improved safety with a general safety duty and the adoption of a national regulatory approach via Commonwealth law.

The net impact of this option, relative to the base case, over a 20-year time period is estimated to be $2.3 billion. Almost all of this is attributable to the benefits of automated vehicles being able to be realised sooner, as the other costs and benefits almost net out one another.

The estimated (quantifiable) impacts of Option 3 are assumed to be the greatest of all the options. The benefits of Option 3 are assumed to exceed Option 4 due to the greater level of consistency that Commonwealth Law provides through the use one of a single court system (federal court). In contrast, State and Territory applied law involves multiple court systems and hence risks inconsistency.

Table 17: Assessment of the impacts of Option 3

Option feature	Type of impacts	Annual impact	NPV of impact over 20 years	Description
		$ millions	$ millions	
Regulatory approach				
General safety duties	Safety benefit	$234.5*	$139.6	Relative to the base case, these are the additional anticipated safety benefits
Regulator				
National	Govt costs	-$25.0	-$280.5	Cost to establish and operate regulators
	Bus. costs	$9.0	$115.6	The costs to business are less than the base case, due to the need to interact with only one regulator (therefore this is a benefit to business / a cost-reduction)
Choice of laws				
Cwlth & S&T laws	Bus. costs	$0.7	$6.6	Commonwealth law is assumed to have the least cost to business and government due to improved consistency
	Govt. costs	$1.4	$15.2	
Sub-total of impacts			**-$3.6**	
Delay impacts				
Benefits of automated vehicles able to be realised sooner	Safety, productivity benefits	N/A	$2,342.8	Relative to the base case, this is the additional value of realising the benefits of automated vehicles sooner. Only 50% of predicted benefits of automated vehicles have been counted.
Overall impact of the option			**$2,339.2**	

* This is the estimate annual benefit when advanced automated vehicles are fully adopted. It is higher than the predicted benefits over 20 years because we have assumed that only 30 per cent adoption will be achieved by 2039.

4.1.6 Option 4

For Option 4, there would be a single national regulator with powers to enforce general safety duties on ADSEs and ADSE executive officers through State or Territory applied law. The regulator would be based in the State or Territory which enacted enabling legislation.

The assessment of Option 4 is set out in the table below. Relative to Option 1, the anticipated impacts of this option are:

- Additional safety benefits of $139.6 million as a result of being able to address all of the avoidable crashes that would occur without any regulatory interventions.
- Costs to government of $280.5 million to establish and operate a national regulator.
- Cost reductions to business and government of $6.8 million from the added consistency provided by State and Territory applied law.
- Benefits to business of $115.6 million from only having to interact with one regulator.

- Additional benefits of $2.1 billion as a result of being able to realise the benefits of automated vehicles sooner (relative to the base case) – mainly as a result of improved safety with a general safety duty and the adoption of a national regulatory approach via State or Territory applied law.

The net impact of this option, relative to the base case, over a 20-year time-period is estimated to be $2.1 billion. Almost all of this is attributable to the benefits of automated vehicles being able to be realised sooner, as the other costs and benefits almost net out one another.

Table 18: Assessment of the impacts of Option 4

Option feature	Type of impacts	Annual impact	NPV of impact over 20 years	Description
		$ millions	$ millions	
Regulatory approach				
General safety duties	Safety benefit	$234.5*	$139.6	Relative to the base case, these are the additional anticipated safety benefits
Regulator				
National	Govt costs	-$25.0	-$280.5	Cost to establish and operate regulators
	Bus. costs	$9.0	$115.6	The costs to business are less than the base case, due to the need to interact with only one regulator (therefore this is a benefit to business / a cost-reduction)
Choice of laws				
Applied laws	Bus. costs	$0.4	$2.1	State and Territory applied law is assumed to deliver slightly less consistency relative to Commonwealth law, however, it still provides an improvement on the base case
	Govt. costs	$0.2	$4.8	
Sub-total of impacts			**-$18.5**	
Delay impacts				
Benefits of automated vehicles able to be realised sooner	Safety, productivity benefits	N/A	$2,108.5	Relative to the base case, this is the additional value of realising the benefits of automated vehicles sooner. Only 50% of predicted benefits of automated vehicles have been counted.
Overall impact of the option			**$2,089.9**	

* This is the estimate annual benefit when advanced automated vehicles are fully adopted. It is higher than the predicted benefits over 20 years because we have assumed that only 30 per cent adoption will be achieved by 2039.

5 Conclusions

This chapter sets out the conclusions of the CBA and our analysis of the four regulatory options prepared by the NTC.

5.1 Overall impact of the options

The table below summarises the quantitative assessment of the options. Notwithstanding the uncertainties in attempting to quantify the impacts of different options for regulating automated vehicles when they are in service, the conclusions of the analysis are that each of the regulatory options (i.e. Options 2a, 2b, 3 or 4) would be an improvement on the base case (Option 1). Although Option 1 has lower regulatory requirements, the potential for regulatory inconsistencies between jurisdictions and the impact on demand of poorer safety outcomes (or perceptions of safety) point to a high likelihood of delay in rollout.

Option 3 has the highest net benefit, with anticipated net benefits of $2.3 billion over 20 years (2020 to 2039). Based on feedback provided by stakeholders throughout the Consultation RIS process, the benefits from Option 3 are likely to slightly exceed those from Option 4, given the higher level of consistency provided by Commonwealth law relative to State and territory applied law.

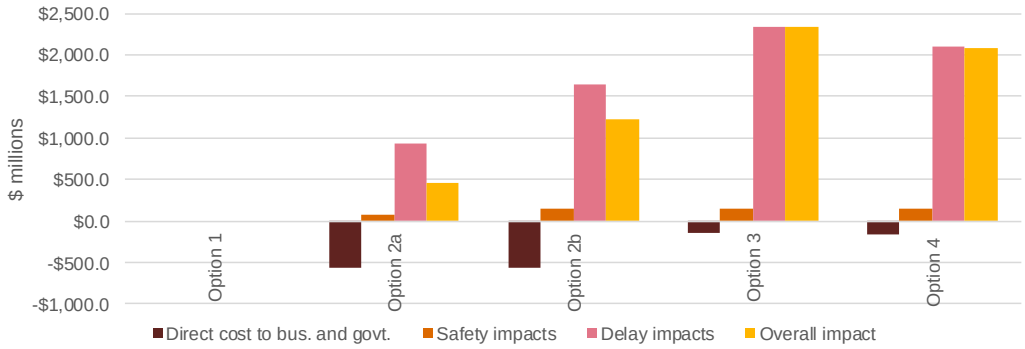
Note the ranking of the options is largely determined by our assessment of the likelihood that the options would either delay or bring forward take-up of automated vehicles, which in-turn would delay or bring forward realising the benefits that automated vehicles are anticipated to provide.

Table 19: Summary assessment of the options (20 years, NPV 7%)

Option	Direct cost to bus. and govt.	Safety impacts	Delay impacts	Overall impact	Ranking of options
	$ millions	$ millions	$ millions	$ millions	Rank
1	$0.0	$0.0	$0.0	$0.0	5
2a	-$559.7	$72.2	$937.1	$449.7	4
2b	-$559.7	$139.6	$1,639.9	$1,219.8	3
3	-$143.1	$139.6	$2,342.8	$2,339.2	1
4	-$158.1	$139.6	$2,108.5	$2,089.9	2

The results of the CBA are most useful in terms of demonstrating a comparison of each option to show the relative rankings. At this point in time, there is too much uncertainty surrounding automated vehicles and the future world in which they will be regulated to have a significant degree of confidence in the NPV values themselves.

Figure 14 – Summary assessment of the options (20 years, NPV 7%)



5.2 Sensitivity analysis

A sensitivity analysis has been conducted to test the robustness of results and provide a level of insight about how changes in different variables will affect the overall CBA. In particular, five scenarios have been applied to the CBA, which align to OBPR's guidance:

- Sensitivity 1: 3 per cent discount rate
- Sensitivity 2: 10 per cent discount rate
- Sensitivity 3: 10-year appraisal period
- Sensitivity 4: 25 per cent of delay impacts realised
- Sensitivity 5: 50 per cent of safety benefits realised.

The results are shown in Table 20 below, demonstrating some considerable changes in the NPV of the options. The choice of discount rate and the level of safety benefits of regulation have not impacted the ranking of the options. The time period of the analysis makes Option 1 relatively more attractive than Option 2a, but does not impact the three Options that rank the highest.

If we only include 25 per cent of the delay impacts, Option 1 becomes more favourable relative to Options 2a and 2b, however Option 3 still leads to the highest NPV, ahead of Option 4.

Table 20: Sensitivity analysis

Option	Overall impact	% change from CBA	Ranking of options
	$ millions	%	Rank
Sensitivity 1: 3 per cent discount rate			
Option 1	$0.0	0%	5
Option 2a	$744.3	66%	4
Option 2b	$1,903.0	56%	3
Option 3	$3,523.6	51%	1
Option 4	$3,155.8	51%	2
Sensitivity 2: 10 per cent discount rate			
Option 1	$0.0	0%	5
Option 2a	$313.2	-30%	4
Option 2b	$900.6	-26%	3
Option 3	$1,780.1	-24%	1

Option	Overall impact	% change from CBA	Ranking of options
	$ millions	%	Rank
Option 4	$1,587.4	-24%	2
Sensitivity 3: 10-year appraisal period			
Option 1	$0.0	0%	4
Option 2a	-$17.6	-104%	5
Option 2b	$258.0	-79%	3
Option 3	$798.4	-66%	1
Option 4	$735.2	-65%	2
Sensitivity 4: 25 per cent of delay impacts realised			
Option 1	$0.0	0%	3
Option 2a	-$253.2	-156%	5
Option 2b	-$10.1	-101%	4
Option 3	$582.1	-75%	1
Option 4	$508.6	-76%	2
Sensitivity 5: 50 per cent of safety benefits realised			
Option 1	$0.0	0%	5
Option 2a	$413.6	-8%	4
Option 2b	$1,150.1	-6%	3
Option 3	$2,269.4	-3%	1
Option 4	$1,985.3	-5%	2

Appendices

Appendix A Assumptions

The following table sets out the key assumptions used in the quantification of the costs and benefits. More detailed discussions about the assumptions and their rationale is contained throughout the report.

Table 21: Key assumptions used in the CBA

Assumption	Value	Discussion / explanation
Benefits of automated vehicles		
Annual benefits to Australia when Automated vehicles are fully implemented	$80.3b	Figure is based on a range of Australian and international studies (normalised for the Australian population, currency etc.) The figure is a constant, the CBA does not explicitly account for changes in population, number of vehicles, vehicle safety (in the absence of automated vehicles), changing structure of the economy etc. accounting for these figures would introduce too many assumptions to the modelling
Realisation of benefits in Australia	See discussion	Benefits of automated vehicles are realised in proportion with their take-up
Take-up of automated vehicles		
Automated vehicles as a % of total vehicles	See discussion	Figure is based on range of different studies of the potential take-up of automated vehicles Growth is assumed to occur exponentially, with around 5% by 2026, and around 30% by 2039 The figures do not separately account for different levels of automation of vehicles over time, as this would introduce too many assumptions to the modelling
Safety benefits		
% reduction in fatalities and hospitalisations due to the use of automated vehicles	68%	Weighted average reduction, based on a reduction in incidents for car driver and passengers by 80%, cyclists 70%, motorcyclists 40%, pedestrians 45%
Reduction in fatalities per 100,000 population with full uptake of automated vehicles	3.4	The current rate of fatalities (4.98), less a 68% reduction due to the use of automated vehicles
Reduction in hospitalisations per 100,000 population with full uptake of automated vehicles	106.1	The current rate of hospitalisations (155.7), less a 68% reduction due to the use of automated vehicles
Cost per fatality	$4.3m	Based on AAA report – cost of road trauma in Australia
Cost per hospitalisation	$220k	Based on AAA report – cost of road trauma in Australia
Impact of regulation on safety outcomes		
% of safety benefits able to be realised without regulation	95%	See discussion in the report
% of safety benefits realised with prescriptive duties	97.5%	See discussion in the report
% of safety benefits realised with a general duty	100%	See discussion in the report

Assumption	Value	Discussion / explanation
Regulator costs		
Annual costs of a national regulator for in-service automated vehicles	$25m	Based on the average costs of a selection of national regulator with comparable functions and scope
Annual costs of State and Territory regulators for in-service automated vehicles	$50m	Assumed to be double the cost of a single, national regulator, due to efficiencies and less duplication of effort
One-off costs to establish a regulator for in-service automated vehicles	50% of annual costs	Based on PwC experience - would need to be re-visited once the tasks and structure of the regulator is determined
Year regulator is established	2021	The most likely year a regulator could be established, given the lead-times for decision making
Year regulator is fully operational	2022	One year following establishment of regulator
Annual change in regulator costs	Nil	The costs are assumed to be consistent over the period of the analysis The regulatory tasks (and costs) will be similar, regardless of the number of vehicles on the road
Costs of legislative approaches		
Annual cost to government associated with the choice of legislative approach	Not valued	The options may present some differences in costs, but these are likely to be small relative to the other costs and benefits considered in the analysis They are too difficult to value at this time
Annual cost to business associated with the choice of legislative approach	Not valued	The options may present some differences in costs, but these are likely to be small relative to the other costs and benefits considered in the analysis They are too difficult to value at this time
Delay costs		
Cost of a one year delay in realising the benefits of automated vehicles over 20 years	$5.2b	Based on the % of benefits that
Likelihood of delay Option 1	50%	See discussion in the report
Likelihood of delay Option 2a	30%	See discussion in the report
Likelihood of delay Option 2b	15%	See discussion in the report
Likelihood of delay Option 3	0%	See discussion in the report
Likelihood of delay Option 4	0%	See discussion in the report
Time period of the analysis		
The time period of the analysis	20 years	This time period helps to account for the uneven profile of benefits and costs over time as automated vehicles are gradually adopted Sensitivity testing has also been conducted for a 10 year period of analysis
Start year	2020	The year that key policy decisions in relation to regulation of automated vehicles will likely be made
End year	2039	The 20th year of the analysis
Discount rate		
Discount rate	7%	Based on OBPR guidance, with sensitivity testing undertaken at 3% and 10% discount rates

Appendix B Competition Assessment

When considering regulatory options Ministerial Councils need to consider what the impact of the proposed regulatory measure on competition will be, including the introduction of new processes and techniques.

During the development of the RIS, the NTC has sought to identify any competition issues that may result from implementing the options identified. Preliminary analysis of where a proposal may restrict competition has been undertaken by working through the questions in the checklist below.[47] As shown below, the NTC did not identify any competition issues and stakeholders did not raise any concerns in their submissions to the Consultation RIS.

Table 22: Competition assessment checklist

Question	Answer	Significance
Would the regulatory proposal limit the number or types of businesses?		
▪ Award exclusive rights for a business in a market (for example, restricting the ability of businesses to supply goods or services in specific geographic locations)	No	
▪ Require businesses to be licensed or authorised	No	
▪ Limit the ability of some types of businesses to provide a good or service	No	
▪ Significantly raise the costs of entry or exit (to a market)	No	
▪ Restrict the geographical flow of goods, services, capital or labour.	No	
Would the regulatory proposal change the ability of businesses to compete?		
▪ Limit the ability of businesses to independently set their prices for goods or services (price regulation)	No	
▪ Limit the freedom of businesses to advertise or market their goods or services	No	
▪ Set standards for product quality that provide an advantage to some businesses over others	Unlikely	Given the emergent nature of the industry, it is hard to say what current/future practice will be. In consultations, industry believed that a general duty would most likely be consistent with future industry practice, but prescriptive duties might result in some differences from standard practice.

[47] See: https://www.pmc.gov.au/resource-centre/regulation/competition-and-regulation-guidance-note

Question	Answer	Significance
▪ Significantly raise costs of production for some businesses relative to others (for example, by creating a standard that is inconsistent with imported goods, or treating existing businesses in the market different from new entrants)	Unlikely	
Would the regulatory proposal reduce the incentives of businesses to compete?		
▪ Create a self-regulatory or co-regulatory regime that includes rules that reduce incentives for businesses to compete	No	
▪ Exempt the activity of a particular industry or group of suppliers from the operation of competition law.	No	
Would the regulatory proposal reduce limit the information available to consumers?		
▪ Limit consumers' ability to choose who to buy from	No	
▪ Reduce the customers' ability to move between suppliers by imposing high 'switching costs'	No	
▪ Limit information available to consumers and thereby reduce their ability to choose effectively between competing businesses	No	

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Appendix D Detailed NPV calculations

The following tables set out the detailed calculation of the benefits and costs for each option

Table 23: Detailed NPV calculation - Option 2a ($m)

	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39
Regulatory approach (safety benefit)																				
General duties	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Prescriptive duties	0.0	0.0	0.5	1.0	1.5	1.9	2.4	4.0	5.6	7.2	8.7	10.3	11.9	13.5	15.0	16.6	18.2	22.7	27.3	31.8
Regulator (cost to business)																				
National	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
State and territory regulators	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Regulator (cost to government)																				
National	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
State and territory regulators	-75.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
Legislative approach (benefit to business)																				
Model laws	0.0	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.0	0.04
Applied laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Commonwealth laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Legislative approach (benefit to government)																				
Model laws	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Applied laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Commonwealth laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	**-74.9**	**-49.9**	**-49.4**	**-49.0**	**-48.5**	**-48.0**	**-47.6**	**-46.1**	**-44.6**	**-43.2**	**-41.7**	**-40.2**	**-38.7**	**-37.2**	**-35.8**	**-34.3**	**-32.8**	**-28.6**	**-24.3**	**-20.0**
NPV	**-74.9**	**-46.6**	**-40.3**	**-37.4**	**-34.6**	**-32.0**	**-29.6**	**-26.8**	**-24.3**	**-21.9**	**-19.8**	**-17.9**	**-16.1**	**-14.4**	**-13.0**	**-11.6**	**-10.4**	**-8.4**	**-6.7**	**-5.2**
Total NPV	**-487.4**																			
NPV of avoided delay in uptake	**937.1**																			
Total NPV of option	**449.7**																			

Table 24: Detailed NPV calculation - Option 2b ($m)

	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37
Regulatory approach (safety benefit)																		
General duties	0.0	0.0	0.9	1.9	2.8	3.8	4.7	7.7	10.8	13.8	16.9	19.9	23.0	26.0	29.1	32.1	35.2	44.0
Prescriptive duties	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regulator (cost to business)																		
National	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
State and territory regulators	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Regulator (cost to government)																		
National	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
State and territory regulators	-75.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
Legislative approach (benefit to business)																		
Model laws	0.0	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Applied laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Commonwealth laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Legislative approach (benefit to government)																		
Model laws	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Applied laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Commonwealth laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	**-74.9**	**-49.9**	**-48.9**	**-48.0**	**-47.1**	**-46.1**	**-45.2**	**-42.1**	**-39.1**	**-36.0**	**-33.0**	**-29.9**	**-26.9**	**-23.8**	**-20.8**	**-17.7**	**-14.7**	**-5.9**
NPV	**-74.9**	**-46.6**	**-39.9**	**-36.6**	**-33.5**	**-30.7**	**-28.1**	**-24.5**	**-21.3**	**-18.3**	**-15.7**	**-13.3**	**-11.2**	**-9.2**	**-7.5**	**-6.0**	**-4.7**	**-1.7**
Total NPV	**-420.1**																	
NPV of avoided delay in uptake	**1,639.9**																	
Total NPV of option	**1,219.8**																	

Table 25: Detailed NPV calculation - Option 3 ($m)

	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39
Regulatory approach (safety benefit)																				
General duties	0.0	0.0	0.9	1.9	2.8	3.8	4.7	7.7	10.8	13.8	16.9	19.9	23.0	26.0	29.1	32.1	35.2	44.0	52.8	61.5
Prescriptive duties	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regulator (cost to business)																				
National	0	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
State and territory regulators	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regulator (cost to government)																				
National	-37.5	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0
State and territory regulators	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Legislative approach (benefit to business																				
Model laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Applied laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Commonwealth laws	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Legislative approach (benefit to government)																				
Model laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Applied laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Commonwealth laws	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
TOTAL	**-36.1**	**-11.0**	**-10.1**	**-9.1**	**-8.2**	**-7.3**	**-6.3**	**-3.3**	**-0.2**	**2.8**	**5.9**	**8.9**	**12.0**	**15.0**	**18.1**	**21.1**	**24.2**	**32.9**	**41.7**	**50.5**
NPV	**-36.1**	**-10.3**	**-8.2**	**-7.0**	**-5.8**	**-4.8**	**-3.9**	**-1.9**	**-0.1**	**1.4**	**2.8**	**4.0**	**5.0**	**5.8**	**6.5**	**7.2**	**7.6**	**9.7**	**11.5**	**13.1**
Total NPV	**-3.6**																			
NPV of avoided delay in uptake	**2,342.8**																			
Total NPV of option	**2,339.2**																			

Table 26: Detailed NPV calculation - Option 4 ($m)

	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39
Regulatory approach (safety benefit)																				
General duties	0.0	0.0	0.9	1.9	2.8	3.8	4.7	7.7	10.8	13.8	16.9	19.9	23.0	26.0	29.1	32.1	35.2	44.0	52.8	61.5
Prescriptive duties	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regulator (cost to business)																				
National	0	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
State and territory regulators	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regulator (cost to government)																				
National	-37.5	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0
State and territory regulators	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Legislative approach (benefit to business)																				
Model laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Applied laws	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Commonwealth laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Legislative approach (benefit to government)																				
Model laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Applied laws	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Commonwealth laws	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	**-37.1**	**-12.5**	**-11.5**	**-10.6**	**-9.6**	**-8.7**	**-7.8**	**-4.7**	**-1.7**	**1.4**	**4.4**	**7.5**	**10.5**	**13.6**	**16.6**	**19.7**	**22.7**	**31.5**	**40.3**	**49.1**
NPV	**-37.1**	**-11.6**	**-9.4**	**-8.1**	**-6.9**	**-5.8**	**-4.8**	**-2.7**	**-0.9**	**0.7**	**2.1**	**3.3**	**4.4**	**5.3**	**6.0**	**6.7**	**7.2**	**9.3**	**11.1**	**12.7**
Total NPV	**-18.5**																			
NPV of avoided delay in uptake	**2,108.5**																			
Total NPV of option	**2,089.9**																			

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