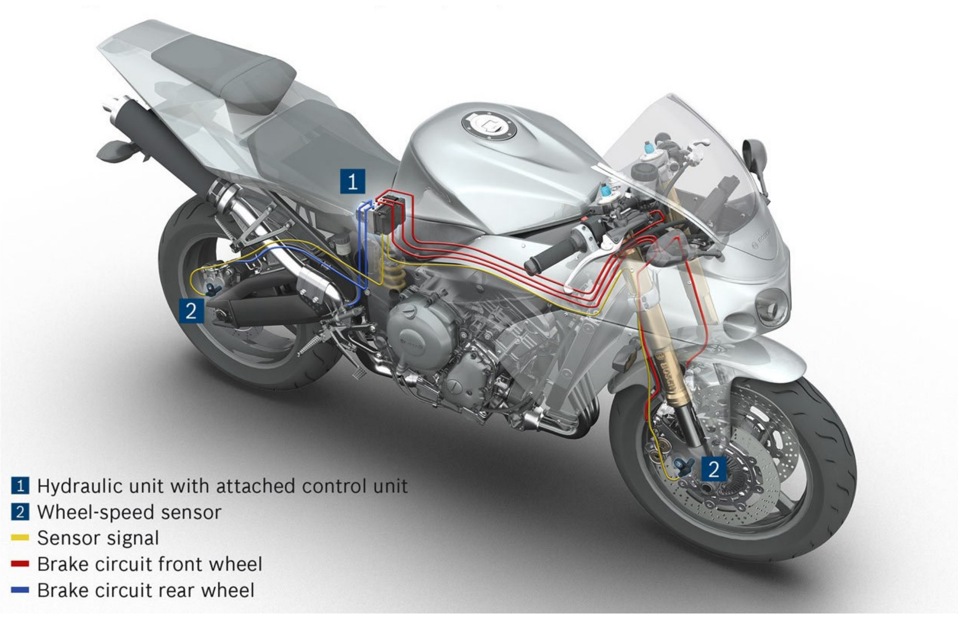
Australian Government

Department of Infrastructure and Regional Development

Regulation Impact Statement

Advanced Motorcycle Braking Systems for Safer Riding



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CONTENTS

EXECUTIVE SUMMARY

The impact of road crashes on society is significant, costing the Australian economy over $27 billion per annum. Motorcycle trauma constitutes $2 billion of this total.

Motorcycles represent only 4 per cent of registered Australian vehicles and only 1 per cent of kilometres travelled. However, in year to May 2016, 228 of the 1,275 Australian road user deaths were motorcyclists, representing 18 per cent of all road deaths. The most frequent age for a motorcyclist fatality is around 25 years. In the year to June 2011, 7,373 of the 33,076 hospitalisations specified as road transport traffic accidents were motorcyclists, representing 22 per cent of all road related hospitalisations. The most frequent age group for motorcyclist hospitalisation is 25 years and under.

Motorcyclist trauma is increasing as the Australian motorcycle sector expands. Motorcycles are the vehicle type currently experiencing the highest growth of sales in Australia. Motorcycle registrations are increasing at approximately 5 per cent per year. This growth results in an increase in the number of novice level riders (including new and returning riders). Expanding sales, a reduced level of rider experience and an increase in net kilometres travelled by motorcycles annually contribute towards the increase in trauma. Overall, motorcycle crashes have grown significantly as a proportion of fatal crashes in Australia - a net 8 per cent increase in motorcyclist deaths for the 10 years to 2014, with a marked net increase in traffic related motorcyclist hospitalisation injuries of 52 per cent occurring over the 5 years to 2009. The most recent available traffic data shows annual growth in motorcyclist deaths at 22 per cent (2016) and annual growth in motorcyclist hospitalisations at 4 per cent (2013).

There have been significant efforts aimed at alleviating trauma risk to motorcyclists. These include initiatives by industry, consumer groups, and state and territory agencies. The initiatives take the form of road user information and awareness campaigns, rider education, training and skills development schemes, safety equipment and technology promotion, market incentives, and infrastructure treatments.

More recently, the most effective countermeasure to motorcyclist trauma has been the increased fitment of advanced motorcycle braking systems. Such systems are well established and have demonstrated a consistent improvement in effectiveness as well as an ongoing reduction in fitment cost.

In line with international initiatives, there have been a number of campaigns across Australia that both emphasise the benefits of advanced motorcycle braking systems and encourage choosing them when purchasing a motorcycle. However, this has not substantially increased uptake in these markets. International research indicates that where campaigns have not achieved targeted fitment rates, regulation can step in to guarantee the safety benefits. As a result, fitment of advanced motorcycle braking systems has now been mandated in major markets such as all 28 member states of the European Union (EU), Japan, Taiwan, Brazil and India.

In addressing the increase in motorcyclist trauma and following on from work undertaken internationally, the Australian Government and Victorian Government in May 2014 jointly commissioned the Monash University Accident Research Centre (MUARC) to examine whether the positive international findings would translate across to Australia. In October 2015 MUARC published the results of that research. The report found that the principal advanced braking system for motorcycles, anti-lock braking systems (ABS), could help in 93 per cent of crash situations. This in practice reduced motorcycle trauma crashes in Australia by 31 per cent overall, including a 36 per cent effectiveness in alleviating serious and fatal trauma crashes. These figures align with international findings.

Notably, advanced braking systems are particularly effective against serious and fatal motorcyclist trauma, which accounts for the overwhelming cost of motorcyclist trauma (in Australia 97 per cent of all motorcycle trauma cost is from serious and fatal injuries).

Australia participates in the peak United Nations (UN) forum (known as WP.29) that sets both the framework and technical requirements for international vehicle standards. The adoption of international standards as a basis for regulation facilitates achieving the highest safety levels at the lowest possible cost to the consumer. Australia is a Contracting Party to the two main treaties for the development of international vehicle standards, the 1958 Agreement that develops UN regulations and the 1998 Agreement that develops Global Technical Regulations (GTRs).

In relation to motorcycle braking systems two UN standards exist, both containing substantively the same requirements - UN Regulation No.78 [Braking – category L vehicles] and GTR No. 3 [Motorcycle brakes]. The majority of contracting parties to the 1958 Agreement including 28 EU member states, Japan, India, Taiwan and Brazil have announced mandates for the fitment of advanced motorcycle braking systems through UN Regulation No. 78.

In line with action item 16c of the National Road Safety Strategy 2011-2020 (NRSS) and action item 7 of the National Road Safety Action Plan 2015-17, the Department of Infrastructure and Regional Development has prepared this Regulation Impact Statement (RIS) to examine the case for Government intervention to reduce motorcyclist trauma through advanced braking systems.

A total of six options, including both regulatory and non-regulatory options were explored: Option 1: no intervention (business as usual); Option 2: campaigns, a - targeted awareness, b - advertising; Option 3: fleet purchasing policies; Option 4: codes of practice; Option 5: mandatory standards under the *Competition and Consumer Act 2010* (C'th); and Option 6: mandatory standards under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) (regulation), a - ABS for motorcycle capacity 50cc and above, b - ABS for motorcycle capacity over 125cc and Combined Braking Systems (CBS) or ABS for motorcycle capacity 50cc to 125cc. Of these options, the viable options 1, 2a, 2b, 6a and 6b were examined in detail. The results of a benefit-costs analysis examining outcomes over a 35 year period for each of these options (from a policy intervention period of 15 years) are summarised in Table 1 to Table 3.

Table 1: Summary of net benefits and gross benefits for each option

	Net benefits ($m)			Total benefits before costs ($m)
	Best case	Likely case	Worst case	
Option 1: no intervention	-	-	-	-
Option 2a: targeted awareness	372	**368**	364	393
Option 2b: advertising	379	**375**	371	468
Option 6a: mandatory ABS	1465	**1452**	1439	1492
Option 6b: mandatory ABS/CBS	1633	**1618**	1604	1663

Table 2: Summary of costs and benefit-cost ratios for each option

	Costs ($m)			Benefit-cost ratios		
	Best case	Likely case	Worst case	Best case	Likely case	Worst case
Option 1: no intervention	-	-	-	-	-	-
Option 2a: targeted awareness	22	**25**	29	18.2	**15.6**	13.6
Option 2b: advertising	89	**92**	96	5.3	**5.1**	4.9
Option 6a: mandatory ABS	27	**40**	54	55.3	**37.1**	27.9
Option 6b: mandatory ABS/CBS	30	**45**	59	55.6	**37.2**	28.0

Table 3: Summary of number of lives saved and severe and minor injuries avoided

	Lives saved	Severe injury	Minor injury
Option 1: no intervention	-	-	-
Option 2a: targeted awareness	97	1186	1353
Option 2b: advertising	190	2337	2666
Option 6a: mandatory ABS	534	7754	7484
Option 6b: mandatory ABS/CBS	587	8522	8225

Option 6b: mandatory ABS/CBS generated the highest net benefits of the options examined ($1.62 billion) as well as the highest number of lives saved (587) over a 35-year run-out period following a 15-year intervention with mandatory standards. This option also yields the highest likely benefit cost ratio of 37.2. It represents significant road trauma savings, especially when compared to other recent vehicle safety initiatives.

There are a number of reasons for the substantial net benefits: firstly, while motorcycles represent only 1 per cent of registered Australian vehicle kilometres travelled, motorcyclists represent 18 per cent of road user fatalities and 28 per cent of hospitalisation trauma. Secondly, of those killed in motorcycle crashes, a high proportion are young, so on average there is significant loss of "life years". Thirdly, advanced braking systems are effective at reducing motorcyclist trauma in the vast majority of crash types, particularly for fatal and serious trauma crashes which are relatively frequent and very costly. Fourthly, the cost of fitment has become relatively low (estimated below AU$ 250 for some models), with major manufacturers well equipped for and experienced in the fitment of advanced motorcycle braking systems. With the high turnover of motorcycles in the current Australian fleet, the benefits of regulation will be realised rapidly by the uptake of new motorcycles fitted with advanced braking systems at a relatively low cost.

According to the Australian Government Guide to Regulation (2014) ten principles for Australian Government policy makers, the policy option offering the greatest net benefit should be the recommended option. In this case it is Option 6b and this was also the option most strongly supported by stakeholders during the consultation process.

The adoption of Option 6b would safeguard Australia from becoming the recipient of lesser-equipped motorcycles, particularly those not permitted for sale in other economies that have already introduced a similar policy option. Harmonisation with international vehicle standards is particularly important because the overwhelming majority of motorcycles sold in Australia are imported.

For these reasons Option 6b - *mandatory standards: ABS for motorcycle capacity above 125cc; and, CBS or ABS for motorcycles with engine capacity above 50cc and engine capacity 125cc or below* is the recommended option.

Under Option 6b the following mandatory requirements, which are in line with EU requirements, would be prescribed in an ADR for new vehicles:

- for motorcycles having engine capacity above 125 cubic centimetres (and equivalent), ABS must be fitted to modulate any wheel lock; and,
- for motorcycles having engine capacity above 50 cubic centimetres (or equivalent) and engine capacity 125 cubic centimetres or below (or equivalent), ABS must be fitted to modulate any wheel lock; or, CBS must be fitted;

where:

- engine capacity 125 cubic centimetres equivalent is defined as net power 11 kW and power/weight ratio 0.1 kW/kg; and,
- engine capacity 50 cubic centimetres equivalent is defined as continuous rated or net power 4 kW.

Stakeholders have also supported allowing the following, which, under Option 6b, would be included in the ADR:

- a means to disable ABS for safe off-road operation of adventure tourer motorcycles designed for dual purpose use (on-road and off-road); and
- an additional exemption for some Australian specific motorcycles (small mass and capacity "trail" motorcycles) designed primarily to be ridden off-road.

Based on feedback during consultation as well as general consideration of the type of design, testing and production changes needed to implement Option 6b, the recommended implementation schedule is:

- 1 November 2019 for all new model ADR category LC motorcycles.
- 1 November 2021 for all ADR category LC motorcycles.

This RIS has been written in accordance with Australian Government RIS requirements, addressing the assessment questions as set out in the Australian Government Guide to Regulation (2014):

1. What is the problem you are trying to solve?
2. Why is government action needed?
3. What policy options are you considering?
4. What is the likely net benefit of each option?
5. Who will you consult and how will you consult them?
6. What is the best option from those you have considered?
7. How will you implement and evaluate your chosen option?

In line with the principles for Australian Government policy makers, the regulatory costs imposed on business, the community and individuals associated with each viable option were quantified and measures that offset these costs have been identified.

1 WHAT IS THE PROBLEM?

1.1 Motorcycle Related Road Trauma

Road trauma impacts significantly upon society. Individuals injured in crashes must deal with pain and suffering, medical costs, lost income, higher insurance premium rates and vehicle and infrastructure repair costs. For society as a whole, road crashes result in enormous costs in terms of lost productivity and property damage. The cost to the Australian economy has been estimated to be at least $27 billion per annum. This translates to an average of over $1,100 per annum for every person in Australia. The cost is borne widely by the general public, businesses, and government. Road trauma has a further effect on the wellbeing of families that is not possible to measure.

Motorcyclists ride for various reasons including recreation, low-cost transport or ease of commuting in congested areas. However, the reality is that an Australian motorcycle rider or passenger is faced with approximately 20 times [1][1] the fatality risk and 41 times the serious injury risk [2] per kilometre to that of a car occupant.

The situation is not unique to Australia. The European Transport Safety Council (ETSC) reported the risk of a motorcycle user having a fatal accident is 20 times greater than for a car user [3]. In Australia, trauma risk increases with the growth in the motorcycle sector and an according reduction in average rider experience, as well as an increase in motorcycle kilometres travelled annually.

The end result is that road trauma risk is increasing annually, with motorcycle crashes growing as a proportion of fatal crashes in Australia. Motorcycle crashes have grown significantly as a proportion of fatal crashes in Australia - a net 8 per cent increase in motorcyclist deaths for the 10 years to 2014, with a marked net increase in traffic-related motorcycle hospitalisation injuries of 52 per cent occurring over the 5 years to 2009 [4]. The most recent available traffic data [1] shows annual growth in motorcyclist deaths at 22 per cent (2016) and annual growth in motorcyclist hospitalisations at 4 per cent (2013). Based on Australian Government Office of Best Practice Regulation (OBPR) 'willingness to pay' estimates [5], motorcycle trauma currently costs the Australian community $2 billion per annum.

Motorcycle crashes occur with a higher frequency and higher injury and fatality risk than for other vehicle types. The Centre for Accident Research & Road Safety Queensland (CARRS-Q) report that approximately 80 per cent of motorcycle crashes result in trauma compared with 20 per cent for automobiles [2].

Austroads report that relative to passenger car drivers, motorcycle riders in Australia and comparable overseas jurisdictions are far more likely to be killed or injured in a crash. Motorcycle riding carries the highest crash, fatality and injury risk of any motorised road vehicle. CARRS-Q, Austroads, and others, have identified that trauma risk increases for motorcyclists due to numerous factors [6, 2]:

[1] 2015 BITRE research showed an Australian motorcycle rider/passenger ran 26 times the fatality risk per kilometre of a car driver/passenger [4].

- A lack of on-board bracing equipment, protective barriers and devices (such as seatbelts, airbags and crumple zones) which may otherwise protect an operator in collisions with vehicles, road-side structures and infrastructure. Motorcycles are not generally able to support rider protection during or after a collision.
- High power to weight ratios capable of high acceleration and speed, which is a common factor associated with an increase in the rate and severity of road trauma.
- Reduced or unexpected visual conspicuity in comparison to other vehicle types.
- Sensitivity to effective braking. Motorcycles commonly have separate front and rear braking systems which require operator balancing to achieve effective braking.
- Instability. Motorcycles do not remain stably upright, for instance, after the onset of excessive front wheel lock (skidding).
- Traction is critical and is sensitive to surface conditions such as wet, unsealed, pot-holed or oily roads. Motorcycle tyres generally have a reduced road contact patch in comparison to cars and traction patterns and compounds may be suited to a reduced set of road conditions.
- Inexperienced, young, and unlicensed riders. Approximately 20 per cent of Australian motorcycling fatalities involve riders who do not hold a valid motorcycle licence. A study of Queensland data from 2001 to 2005 [7] found that the number of motorcycle crashes involving young riders had increased by 83 per cent. Over the last decade, sales of scooters and mopeds have increased at a greater rate than for other types of on-road motorcycles and much of the marketing is aimed at young demographics. The fatality rate (expressed in terms of distance travelled) for motorcyclists aged 17-25 is three times that of riders aged 26-39 and is more than 30 times higher than for passenger car drivers aged 17-25 [8]. Growth in the motorcycle sector further increases the proportion of inexperienced riders.

The study of Queensland motorcycle crash data from 2001 to 2005 [7] also found that the trauma severity profiles of motorcycle and moped crashes were similar. That is, safety improvements are equally important for all motorcyclists regardless of the size of the motorcycle they ride.

The most critical injuries to motorcyclists in crashes are upper torso and head injuries [9]. While head, spine, and chest injuries are a major cause of death in fatal crashes, these injuries in non-fatal crashes are also associated with long term morbidity and present a significant financial burden for the community in terms of high lifetime care costs, as well as the impact they have on the individuals involved and their families. Unlike passenger vehicle crashes where serious injuries are much less common than minor injuries, they are almost equal in motorcycle crashes. Due to the reduced capability of motorcycles to offer any impact protection during and after a collision, motorcycle pre-crash and crash avoidance technologies offer the greatest potential to reduce the rate of motorcycle deaths and injuries.

1.2 Extent of the Problem in Australia

Motorcycle Numbers

At the time of the 2014 Motor Vehicle Census there were 17.6 million motor vehicles, including 780,174 motorcycles (4.4 per cent of the fleet), registered in Australia. Compared to other vehicle types, new motorcycles experienced the largest growth rate over the five years to 2014 with an increase of 25 per cent [10] (Figure 1).

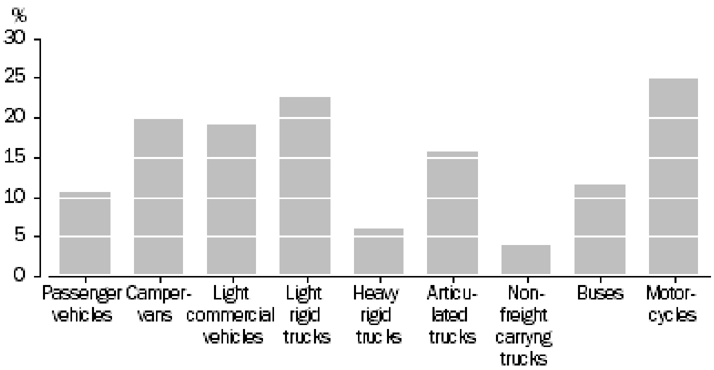

Figure 1: Growth in Australian road user types 2009-2014

Motorcyclist Fatalities

In the year to May 2016, 228 of the 1,275 Australian road user deaths were motorcyclists [11] (Table 4). This represents 18 per cent of all road user deaths. The trend in motorcyclist fatalities is increasing. The Transport Accident Commission of Victoria (TAC) reports an 87 per cent increase in Victorian motorcyclist deaths occurred in calendar year 2016 over 2015 [12], and Bureau of Infrastructure, Transport and Regional Economics (BITRE) statistics show an Australia-wide 22 per cent increase over the same period (from 203 to 248 rider fatalities) [13]. Despite increases (over the last decade) in motorcyclist fatalities for riders aged 40 to 64, the most frequent age for a motorcyclist fatality is still around 25 years. Young motorcycle riders have more crashes per vehicle kilometre travelled than other riders [9][2].

[2] In 2012, Australian motorcyclist fatalities per million vehicle kilometres travelled for riders age 15 to 24 was 3.2 (1.2 for all riders) [1]

Table 4: Motorcyclists represented 18 per cent of road user fatalities in the 12 months to May 2016

12 months ended May	Driver	Passenger	Pedestrian	Motorcyclist [b]	Pedal [b] cyclist	Total [c]
2012	565	271	195	206	35	1,274
2013	624	242	154	215	35	1,277
2014	524	221	163	187	61	1,158
2015	542	235	150	203	28	1,161
2016	606	234	168	228	37	1,275
Latest per cent change	11.8	-0.4	12.0	12.3	32.1	9.8
Average trend change per year (per cent)	0.0	-3.2	-3.2	1.5	-1.1	-0.9

Motorcyclist Hospitalised Injuries

In the year to June 2011, 7,373 of the 33,076 road user hospitalisations specified as land transport traffic accidents were motorcyclists [14]. This represented 22 per cent of all road user hospitalisations. By 2013 the number of motorcyclist hospitalisations increased to 7,794 [15], a five per cent increase over two years. The most frequent age group for motorcyclist hospitalisation is 25 years and under.

The above fatality and hospitalisation data shows that motorcyclists represent 18 and 28 per cent of all road user deaths and hospitalisations respectively. This is significant, especially given that they only represent around 4 per cent of the fleet. The extent of the problem is growing with inexperienced new and returning motorcyclists increasing in number due to the increasing popularity of motorcycling. Unfortunately this also means that deaths and injuries are increasing faster than for other road users, with the exception of pedal cyclists.

1.3 Government Actions to Address the Problem

Current government actions to address the problem of motorcyclist deaths and injuries involve market and consumer related actions such as safety awareness campaigns, as well as rider training/licensing, infrastructure treatments and other improvements in vehicle systems.

In the case of improvements in vehicle systems, there are existing regulations that set minimum safety requirements for motorcycles. More recently there has been a concerted effort of both government and market-based organisations to encourage purchasers of new motorcycles to request additional safety technologies.

Government Campaigns

There has been long-term government action at both state and territory level as well as federal level to reduce the road trauma risk to motorcyclists. This has included road user information and awareness campaigns, rider and road user education, promotion of safety equipment and technology, as well as market incentives.

The Government recognises the importance of motorcyclists using appropriate safety equipment. In order to keep motorcyclists informed of the latest information about safety equipment, The Good Gear Guide [16], a 2014 booklet containing clear and useful advice for motorcyclists to consider when purchasing motorcycle safety equipment, was developed and made available for distribution throughout Australia.

More recently there has been support for the fitment of advanced motorcycle braking technologies by way of various campaigns (many online) that both emphasise the benefits of Anti-lock Braking Systems (ABS) and encourage choosing it if possible when purchasing a motorcycle. Campaigns for motorcycle ABS fitment in Australia have been run by state and territory jurisdictions including NSW [17] and Victoria [18] as well as Spokes and the TAC [19]. Vicroads has developed a web database covering the availability of motorcycling safety technologies [20] which it believes is the first vehicle safety consumer information system for motorcyclists globally. The website promotes choosing motorcycles fitted with ABS and the consideration of emerging safety technologies and initiatives.

Rider Training/Licensing

All Australian State and Territory jurisdictions require motorcycle learner's license applicants to pass a practical component (assessment and/or training) before obtaining a learner's license. All learner riders must ride approved motorcycles and observe a zero blood alcohol content restriction, regardless of age. Various restrictions on pillion passenger carriage also apply. The learner's license tenure period varies across jurisdictions. Several conditions are common to each jurisdiction for riders in the subsequent intermediate license phase including the requirement to display a "P" plate and use certain motorcycle types. Progression to an unrestricted license varies between jurisdictions based on either the completion of a minimum intermediate license tenure period and/or practical rider assessment.

In 2011, the Austroads Safety Task Force initiated research to review licensing arrangements for motorcycle riders in support of related actions in the National Road Safety Strategy (NRSS) 2011-2020. As an output of that initiative, in 2014 an Austroads report [6] noted that car driver licensing and training are well researched and that most jurisdictions in Australia, New Zealand and overseas had implemented graduated licensing systems (GLS) for car drivers and the pool of evaluation evidence available was expanding. However, the report recognised that research of such interventions for motorcyclists is a relatively less traversed field. The Austroads report went on to examine a consistent and effective approach to graduated motorcycle rider licensing. The report examined:

- Pre-requisite licensing requirements, such as age and driver licensing tenure.
- Supervised riding requirements; mandatory training.
- Novice riding restrictions, such as night riding, blood/breath alcohol concentration, mobile phone or other technology restrictions.
- Motorcycle power restrictions and learner approved motorcycle schemes.
- Hazard perception testing.
- Options for people returning to motorcycle riding after a long break.
- Re-testing; motorcycle safety technology (such as ABS).
- Specific sanctions for speed, alcohol or other offences.
- The introduction of a specific licence for motorcycle riders.

The report summarises the findings of a literature review of the evidence of effective motorcycle rider licensing systems and interventions in Australasia and internationally. Identifying best practice approaches was difficult as few motorcycle licensing elements and practices have been evaluated for their effectiveness in reducing motorcycle crash or injury or their validity, reliability, equity and/or cost-effectiveness. Elements of a best practice GLS for novice rider licensing were outlined.

In Victoria, an updated motorcycle GLS introduced new safety restrictions for motorcycle learner permits or licences. Victorian motorcycle learner permits granted from 2 April 2016 require completion of an on-road practical skills check (also known as a Check Ride) before a motorcycle licence assessment can be booked.

The NSW Roads & Maritime Motorcycle Rider Training Scheme is a training and testing program primarily designed to help people gain basic riding skills before riding on the road [21]. NSW provides both pre-learner and pre-provisional rider training services at accredited training centres including Stay Upright and Wheel-Skills. Stay Upright rider training is a Registered Training Organisation (RTO) offering motorcycle rider training and a diverse range of courses designed to improve the attitude, skills and knowledge of all motorcyclists. Wheel-Skills offers courses that aim to minimise the chance of a motorcyclist being involved in a road crash with training focused on road safety principles, the objective being to assist the development of advanced low-risk driving and riding skills, which result in enhanced on-road safety.

In Queensland, a competency based training and assessment program (Q-Ride) and a practical riding test run by driving instructors through the Department of Transport (Q-Safe) aims to ensure participants reach a demonstrated level of skill and proficiency as a motorcycle rider. Q-Ride courses are delivered by Q-Ride training providers (accredited by the Department of Transport and Main Roads) offering three Q-Ride courses: pre-learner, restricted and an unrestricted course. This arrangement stems from a three-year CARRS-Q program of road safety research services for motorcycle rider safety. Research was undertaken to produce knowledge assisting the Department of Transport and Main Roads to improve motorcycle safety by strengthening the licensing and training system to make learner riders safer by developing a pre-learner package; by evaluating the Q-Ride program to ensure that it is maximally effective and contributes to the best possible training for new riders; and by identifying potential new licensing components to reduce the incidence of risky riding and improve higher-order cognitive skills in new riders.

In the period 2010-12, State and Territory stakeholder consultations on motorcycle licensing highlighted that engine capacity restrictions alone were ineffective at limiting inexperienced riders' access to more powerful motorcycles and thus compromise their safety [22]. The Learner Approved Motorcycle Scheme (LAMS) register was thereby developed to improve learner safety. Under LAMS, motorcycles with a power-to-weight ratio of 150 kilowatts per tonne or less and an engine capacity of 660 cc or less qualify for the register. Motorcycles with engine capacities of 0 to 260 cc inclusive, in their standard manufacturer form, are automatically approved under LAMS with the exception of a several models considered unsuitable for learners or over-represented in crashes. All motorcycles manufactured prior to

1960 with a cubic capacity up to and including 660 cc, and currently available fully electric powered motorcycles are approved for use by novice riders. The list, managed by VicRoads, is updated as suitable new models are approved for inclusion.

Over the same period, the Department of Infrastructure and Regional Development promoted a skills-based approach to rider training via the Ride-On training resource, a DVD and booklet developed in consultation with rider trainer consultants such as Driver Improvement Consultancy, Honda Australia Rider Training, Motorcycle Council of NSW, Federal Chamber of Automotive Industries (FCAI) Motorcycle Group, and motorcyclist club representatives [23].

Infrastructure Treatments

Research published by Austroads [24] in July 2016 demonstrated that elements of road infrastructure influence crash risk and severity such that motorcycles should be considered as a 'design vehicle' during road design, asset management and maintenance practices. The study concluded that infrastructure related motorcycle crash risk can be managed, but requires changes in practice, design, asset management funding and routine maintenance performance contracts. One example proposal is in the identification of road sections and/or routes that pose the highest crash risk to motorcyclists, so that they can be managed and maintained appropriately. In addition, the research advocates having proactive and motorcycle specific safety assessments of the network, as well as fine-tuning the design parameters for roads carrying significant volumes of motorcycles (e.g. horizontal geometry, sight lines, lane and shoulder width, intersection types, intersection quality and controls). It also suggests that the range and detail of infrastructure mitigation measures be expanded.

Infrastructure treatments may play an important role in reducing motorcyclist trauma via improved road configurations, as well as reducing trauma severity to a fallen rider, however, they may not be as effective in alleviating other motorcycle collision types (crashes involving speeding, rider error, additional vehicles, etc) and any benefits are geographically localised. In-line with Austroads' recommendations, State and Territory road authorities may prioritise motorcycle infrastructure treatment programmes in high motorcycle use/trauma road sections. Such localised programmes may involve longer lead and implementation timeframes and high investment.

Rider Safety Apparel

Numerous campaigns have emphasised the benefits of personal safety apparel such as riding helmets, jackets, pants, gloves and boots.

Motorcycle helmets must conform to a minimum standard of safety and impact protection, originally Australian/New Zealand Standard 1698: Protective Helmets for Vehicle Users [AS/NZS 1698]. In November 2015, Ministers agreed that a process to pursue greater consistency in helmet approval arrangements across State and Territory jurisdictions should be progressed. A revocation of the Australian Competition and Consumer Commission's (ACCC) original mandatory product safety standard for motorcycle helmets allowed jurisdictions to permit the purchase and use of helmets meeting the updated United Nations (UN) Regulation No. 22/05. Most jurisdictions now allow the UN standard.

Though minimum standards exist, some helmets may perform better than others. The Consumer Rating and Assessment of Safety Helmets (CRASH) provides riders with independent and consistent information on the levels of protection from injury in a crash provided by motorcycle helmets and the comfort level of the helmet. The program is funded by Transport for NSW and the TAC.

The Department of Infrastructure and Regional Development promotes "*The Good Gear Guide for Motorcycle and Scooter Riders*" [25]. The guide discusses apparel that may improve riding comfort and could alleviate preventable injuries as well as improve riding and enjoyment by protecting riders from the elements.

All State and Territory road authorities provide similar advice on their respective web sites. For instance, VicRoads recommends protective clothing for riders as a countermeasure to impact and abrasion in the event of a crash. Protective clothing is promoted as an investment against potential medical expenses as well making riding a more comfortable and enjoyable experience. Vicroads promotes such apparel via the Commonwealth's Good Gear Guide as well as Vicroads' own guide: "*The Right Stuff - guide to protective gear*" that explains the type of protective clothing that should be worn when riding a motorcycle or scooter. Spokes and the TAC also make recommendations on choosing the best motorcycling gear [26].

Improvement in Vehicle Systems

Minimum motorcycle performance standards are set nationally. The Government administers the *Motor Vehicle Standards Act 1989* (MVSA), which requires that all new road vehicles, whether they are manufactured in Australia or are imported, comply with national vehicle standards known as the Australian Design Rules (ADRs), before they can be offered to the market for use in transport in Australia. The ADRs set minimum standards for vehicle safety, emissions and anti-theft performance.

One of them most critical safety system on a motorcycle is the braking system. ADR 33/00 – Brake Systems for Motorcycles and Mopeds (2007) is the national standard that sets the requirements for safe braking under normal and emergency conditions for motorcycles and mopeds. ADR 33 was last updated in 2007 to also allow certification to the latest version of the international standard UN Regulation No. 78 [27] or its companion Global Technical Regulation (GTR) No. 3 [28]. Motorcycles supplied into Australia can now comply with ADR 33/00 by meeting the original and locally developed requirements in the main body of the text, or by meeting the requirements of UN R78 or GTR 3. ADR 33 does not mandate advanced braking systems such as ABS, but it does contain performance requirements to be met where ABS is fitted. This complements any campaign to increase fitment of ABS, as the technical performance requirements already exist in the ADRs.

Despite the actions taken by government as well as non-government organisations (Section 2) motorcyclist deaths and injuries continue to grow, especially amongst new and inexperienced motorcyclists due to the increasing popularity of motorcycling.

1.4 The National Road Safety Strategy 2011-20

Under the National Road Safety Strategy 2011-2020 the Australian Government and state and territory governments have agreed on a set of national road safety goals, objectives and action priorities through the decade 2011-2020 and beyond. It aims to reduce the number of deaths and serious injuries on the nation's roads by at least 30 per cent (relative to the baseline period 2008-2010 levels) by 2020, as endorsed by the Transport and Infrastructure Council (TIC) in 2011.

An updated National Road Safety Action Plan 2015-17 was developed cooperatively by federal, state and territory transport agencies, and was endorsed by the TIC in November 2014. The Action Plan is intended to support the implementation of the NRSS, addressing key road safety challenges identified in a recent review of the strategy. It details a range of national actions to be taken over the period.

One of the main actions under the plan is to consider the case for mandating advanced braking systems for motorcycles. With motorcyclists representing 18 per cent of road fatalities and 28 per cent of road trauma hospitalisations, improvements in braking have the potential to contribute considerably to the NRSS target of reducing Australian road trauma by at least 30 per cent.

2 WHY IS GOVERNMENT ACTION NEEDED?

Government action may be needed where the market fails to provide the most efficient and effective solution to a problem

2.1 Market and Consumer Action

Availability of technologies

There have been opportunities for the market to reduce the road trauma risk to motorcyclists through the adoption of new or improved safety technologies.

For the rider there is better personal safety apparel and protective clothing while for the motorcycle there are systems such as advanced braking technologies - ABS and Combined Braking Systems (CBS), as well as emerging systems such as Electronic Stability Control (ESC), and Connected Intelligent Transport Systems (C-ITS). Further into the future systems that monitor fatigue and speeding, alcohol interlocks and devices to monitor speeding and risky behaviour may become more commonplace.

From the currently available technologies, none are marketed as more effective or viable in reducing road trauma for motorcyclists than advanced braking technologies such as ABS and CBS. These types of braking systems are designed to be effective against several of the inherent factors identified in paragraph 1.1 that contribute toward a motorcyclist's vulnerability. This includes sensitivity of the vehicle to effective braking, the instability of being in a two-wheeled configuration, as well as the limited traction that is available.

Market promotion of technologies

Due to its potential to reduce road trauma, support for fitment of advanced motorcycle braking technologies in Australia has come via manufacturer promotions as well as through campaigns by non-government organisations representing road users including the National Roads and Motorists' Association (NRMA) [29], Royal Automobile Club of Victoria (RACV) [30] and Motorcycling Australia.

Internationally, research and campaigns in support of ABS fitment include initiatives from Bosch [31], Continental [32], Global New Car Assessment Program (NCAP_ [33], the Institute for Advanced Motorcyclists (IAM) [34], the Association of European Motorcycle Constructors (ACEM) [35], and Federation Internationale de l'Automobile (FIA) [36]. In these campaigns, the most important factor is generally that the targeted technology is readily available as a fitment option (rather than comparing the performance of different designs).

Consumer response

Historically, Australian consumers have chosen to purchase highly protective personal safety apparel and motorcycles fitted with new and improved safety technologies only to a limited extent. Manufacturers are well positioned to satisfy any consumer desire to provide the Australian market with motorcycles fitted with safety technologies. However, the appeal to some of motorcycling as being a low cost activity, as well as perhaps an overall acceptance by some that motorcycling is a higher risk activity anyway, may be limiting this desire.

This may be compounded by some retailers preferring to prioritise sales figures and/or promote more economical motorcycle variants, rather than those fitted with additional safety features (at an increment in cost).

2.2 Government Commissioned Research and Consultation

2.2.1 Research

Both internationally and domestically, campaigns promoting the uptake of advanced motorcycle braking systems have been intense. Despite this, the rate of uptake by consumers remains relatively static.

In May 2014 the Australian Government, in partnership with the Victorian Government through VicRoads, commissioned research into the effectiveness of ABS on motorcycles towards reducing deaths and injuries of motorcyclists in Australia. This research built upon cutting edge international work to identify the benefits of ABS within the Australian context using an internationally adopted *induced exposure* methodology. In doing so it was able to report on the real-world effectiveness in Australia with a high degree of accuracy. In October 2015, Monash University Accident Research Centre (MUARC) published the results of that research [37]. The research found that in Australia ABS would be 33 per cent effective in reducing all motorcycle injury crashes and 39 per cent effective in serious and fatal motorcycle crashes.

2.2.2 Preliminary Consultation and Public Discussion Paper

In December 2015 the Department met with a number of Australian peak motorcycling bodies to discuss the MUARC research. Meetings were hosted by jurisdictional agencies as part of their regular consultation program, with attendance from relevant expert and interest groups covering industry, insurance providers, trainer/educators, motorcyclist groups and police. This preliminary consultation helped to draw out any issues.

The meetings were followed by the release of a public discussion paper [38] which has been hosted on the Department’s website since 26 December 2015 when it was circulated to peak motorcycling bodies. The public discussion paper invited comment from all motorcyclists and other interested parties on the findings of the research until 26 February 2016.

Fifteen submissions were received. There was broad consensus that the fitment of motorcycle ABS offers safety benefits. The overwhelming view (greater than 90 per cent of respondents) was recognition of the benefits of motorcycle ABS. The second most frequent view (greater than 60 per cent of respondents) was that a temporary ABS off (or reduction) switch should be allowed to be fitted, for use on unpaved road surfaces. The third most frequent view (greater than 40 per cent of respondents) was that there should be an accelerated fitment of ABS to motorcycles, at rates beyond ‘business as usual’.

In addition to these views and particularly during the consultation meetings, expert rider training representatives considered how best to train new riders in the correct operation of ABS, in order to maximise its effectiveness. However, it should be noted that suppliers of modern ABS contend that the capability of vulnerable riders (e.g., inexperienced riders, riders operating in conditions of variable traction, and riders confronted by unexpected emergency braking) improves significantly just in having ABS fitted and before accounting for any additional benefits of training. Bosch, for example, recommends: "The first rule of braking with ABS: brake as though you do not have ABS" [39]. In other words, ABS works best when a motorcycle is braked in the normal way.

The facts behind Bosch's recommendation become evident from the numerous studies of real crash data over the past decade, but particularly the MUARC research. These studies have involved a representative cross section of the general riding public, rather than just riders trained in the use of advanced braking systems. Although it is true that training could further increase the effectiveness of ABS beyond the rates reported in these studies, this analysis did not examine the costs or benefits in doing so. Instead, it left this as a matter for state and territory road agencies that deal with rider licensing and training to consider further.

2.3 The need for further Government Action

As discussed earlier, motorcycles have the highest growth of any vehicle type on Australian roads. This has led to a corresponding increase in new and inexperienced motorcyclists and with it increases in fatalities and injuries. While trauma crashes involving other vehicle types have shown substantial decreases in fatalities and injuries over time, trauma to motorcyclists has increased and crashes involving motorcycles continue to occur at levels well beyond those of other vehicle types. Awareness campaigns, rider training/licensing, improvements in safety technologies and infrastructure treatments have been used by the private and public sector to some effect. However, the problem of increasing trauma persists.

Research has shown that advanced braking systems have the potential to significantly reduce fatalities and injuries of motorcyclists. Manufacturers have demonstrated the ability to increase fitment of these systems, for example in countries where it has been mandated. Despite this, consumers in Australia have not been inclined towards purchasing motorcycles with advanced braking systems. This means that fitment rates have remained relatively low. They have recently beginning to show some improvement (Section 4.2.1), but there remains a significant capacity to increase fitment of ABS and CBS in Australia. Government action may be justified in this regard as markets have failed to provide the most efficient and effective solution to the problem of increasing road trauma amongst motorcyclists.

Due to the unique crash and age profile of Australian motorcycles, any government action to increase the fitment of ABS and CBS would penetrate the fleet rapidly. This would mean that reductions in deaths and injuries would be realised earlier for motorcycles than when similar requirements were set for other vehicle types (for example, the ADRs mandating ESC for light vehicles in 2011, ABS for heavy vehicles in 2014 and Brake Assist Systems for light vehicles in 2015). For example, the difference in crash distribution by age for motorcycles and light vehicles is most pronounced at around 5 years (Figure 2). At this age, motorcycles are around 30 per cent more likely to be involved in an accident than a passenger vehicle.

Increased uptake of ABS and CBS would be particularly beneficial to the increasing number of new and inexperienced motorcyclists in the community. Over the last decade, much of the sector's marketing has been aimed at the young and so sales of scooters and mopeds have been particularly high (Figure 3). Despite the correspondingly high trauma rates for these motorcyclists, the market has not responded with sufficient improvements in safety.

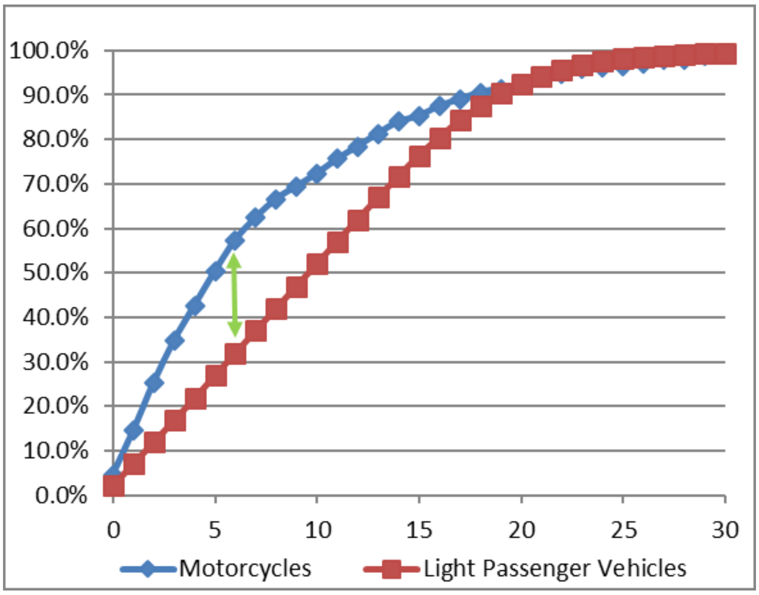

Figure 2: Highlighting the difference between crash distribution by age for Australian motorcycles and light passenger vehicles [35].

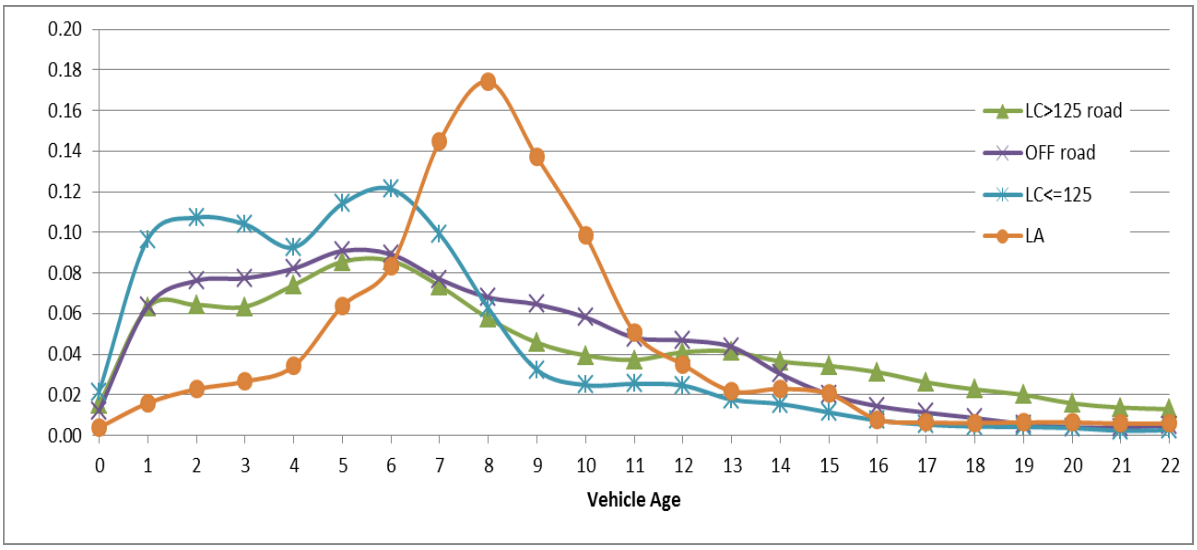

Figure 3: MUARC - Average 2013-2014 age distribution of Victorian motorcycles by vehicle type (from 0 to 22 years)

There is an existing mechanism available to government that could increase the fitment of ABS and CBS. The adoption of international vehicle safety standards is a well-established way of bringing road trauma reductions to Australian road users at the lowest possible cost. Mandating effective vehicle safety technologies is known to reduce cost to consumers [40], ensure consumer access, and preclude consumer hesitation towards such technologies. Alignment with international standards ensures that Australia does not set unique requirements that restrict manufacturers. In other major markets where governments have mandated ABS and CBS for motorcycles, circumstances and trends before this were similar to those that exist in Australia now.

2.4 Advanced Motorcycle Braking Systems

Advanced motorcycle braking systems are those incorporating ABS and/or CBS. These systems are described below.

ABS

Excessive wheel skid under brake application is known to destabilise a motorcycle and increase stopping distances. Conversely, where a rider hesitates to brake sufficiently close to the tyres' tractive limit (to try to avoid skidding), stopping distances also increase. With ABS fitted, a rider can be confident that full brake force can be applied without risk of skidding and destabilising of the motorcycle.

ABS is a closed-loop part of the braking system (Figure 4) that monitors the speed at which wheels are rotating and rapidly modulates brake pressure when it detects that the wheel(s) are about to lock. This allows the motorcycle to stop with no or minimal skidding. Motorcycle ABS typically uses sensors on both wheels to accurately determine wheel speeds, as well as a control unit to determine the extent of wheel lock. If a wheel is showing signs of locking (eg due to excessive braking or braking under slippery road conditions), the ABS hydraulic unit momentarily modulates (reduces) the excess brake pressure applied by the rider, so that the tyre may continue to retain road traction.

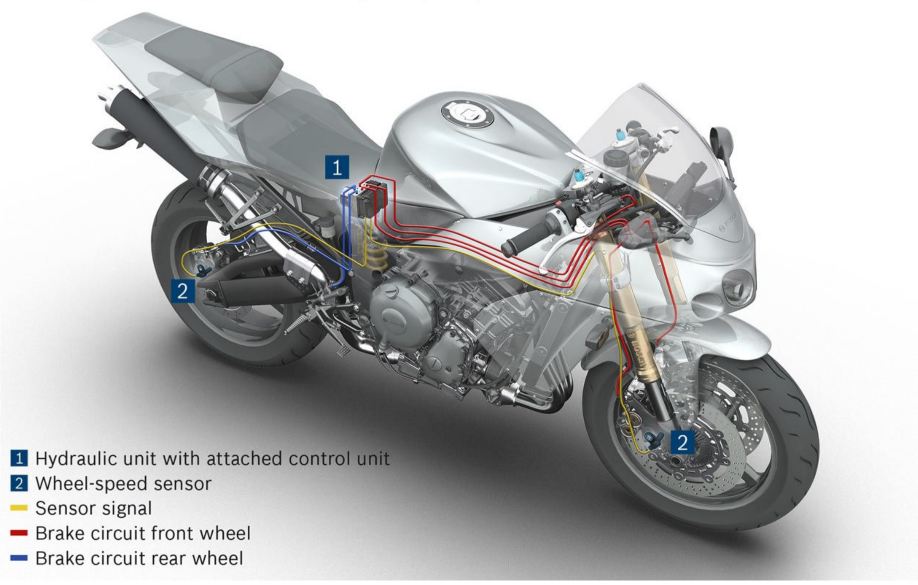

Figure 4: Motorcycle ABS – example system by Bosch[3]

[3] Reproduced from http://mylicence.sa.gov.au/safe-driving-tips/safer-vehicles/motorcycleabs

ABS modulation is rapid and cyclical. A rider normally will not experience modulation during normal braking, within the tractive limit of the tyre-road interface. However, the rider can be confident that in an emergency full brake force can be applied without the risk of instability due to wheel lock, and that deceleration will be maintained at the highest rate possible regardless of road surface condition.

Testing has shown that both inexperienced and experienced motorcycle riders are able to use braking capacity consistently and effectively with ABS, regardless of road surface variations, with inexperienced riders able to achieve decelerations closer to that of experienced riders.

Although established for many years on passenger and heavy vehicles, ABS is less widespread on motorcycles. Research indicates that the effectiveness of ABS in reducing crash risk for motorcycles is higher than for passenger cars. This is attributed to the manner in which motorcycle wheel lock and skidding is likely to lead a motorcycle to slide or overturn, resulting in complete loss of control and so loss of any ability by the rider to avoid or mitigate a collision. This is exacerbated by the likely ejection of the rider directly into the road environment.

CBS

Motorcycle CBS is a service brake system where at least two brakes on different wheels can be operated by the actuation of a single control. CBS is sometimes referred to as a Linked Braking System (LBS). Much like bicycles and unlike other motor vehicles, motorcycle braking front and rear are typically separately operated systems. While experienced motorcyclists can take advantage of a separated configuration to finely balance brake operation, it can lead to poor braking outcomes by less experienced motorcyclists.

CBS ensures that effective braking distribution between the front and rear wheels is obtained. It typically involves a control valve that distributes braking power between wheels when a single brake lever is depressed. In its most basic form, CBS distributes but does not regulate maximum brake pressure, so generally does not prevent wheel lock when a rider applies the brake harder than required to produce maximum deceleration. However, CBS can reduce rear wheel skidding due to excessive rider application of the rear brake by applying a rear brake force balanced suitably to the front wheel brake force. During emergency braking, CBS alleviates the rider from having to balance front and rear brake force manually, eliminating compromised braking due to inappropriate (panicked) rider braking. It has also been shown to reduce stopping distances, even for experienced riders on closed test tracks [41].

As with ABS, CBS may improve general braking performance by reducing hesitation and increasing rider confidence during braking. In particular, CBS helps inexperienced riders to optimise their distribution of braking forces and so helps maintain stability under braking. While not generally as effective as ABS, particularly for larger high performance motorcycles, CBS offers a lower cost improvement in braking for smaller motorcycles.

Availability of advanced braking systems for motorcycles

ABS is available on a range of production motorcycles, either as a standard or optional feature. Several manufacturers equip new road motorcycles with ABS as standard in the Australian market[4], including KTM, BMW, Aprilia, Ducati, Indian and Harley-Davidson[5]. Many motorcycle manufacturers offer ABS as an option, including Can-Am, Honda, Husqvarna, Kawasaki, Suzuki, Triumph, and Yamaha.

As well as promoting its safety benefits, manufacturers increasingly market ABS for super-sport (and racetrack) use. Motorcycles currently available in Australia incorporate race-oriented ABS as part of an electronics package for performance enhancement, including BMW S1000 (standard on R and RR)[6], Ducati Panigale (standard on 899 and 1299)[7], Kawasaki ZX10R ABS[8], Yamaha YZF-R1[9], Honda CBR-1000RR ABS[10], Suzuki GSX-R1000 ABS[11], and others.

Several performance motorcycle models promote advanced ABS with CBS, such as the Yamaha YZF-R1[12]:

> "*The distribution of braking force is based on input from the IMU regarding the machine's attitude and banking angle at the time of brake application. When brake force is applied to both the front brake lever and the rear brake pedal, the Unified Brake System functions to control the distribution of braking force between the two brakes, but when only the rear brake pedal is used, the system operates only the rear brake so that there is no unnatural operational feeling for the rider*."

Traditional (hydraulic) and electronic systems are available in several variations both simple and complex, depending on the type of motorcycle fitted. For example, according to Honda[13]:

> "*Honda's CBS can be largely classified into two types: Combi brake adopted for scooters, medium sized motorcycles and American custom models; and dual CBS used by large sports and large tourers […]. The main purpose of the two types is the same; to increase the deceleration obtained on application of the pedal brake (or the left lever) which was previously relatively lower during the application of the rear wheel brake alone […] it was made possible to apply the brakes simultaneously on the front and rear wheels. In case of dual CBS, furthermore, it was made possible to apply the brakes simultaneously on the front and rear wheels when the right lever was operated to reduce nosedive. […] Honda's [CBS with ABS] creates the optimal balance of front and rear braking forces and the control of an advanced ABS system that helps you stop with confidence on even wet or dirty road surfaces. Honda has also pioneered [eCBS] specially designed to electronically distribute front and rear braking forces to maximize braking in a light-weight, short-wheelbased package.*"[14]

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[4] For a list of makes and models of motorcycles offering ABS, see https://www.vicroads.vic.gov.au/safety-and-road-rules/motorcyclist-safety/abs-for-motorcycles/list-of-motorcycles-with-abs
[5] 500cc LAMS Harley-Davidson does not have ABS as an option.
[6] http://www.bmwmotorrad.com.au/au/en/index.html?content=http://www.bmwmotorrad.com.au/au/en/bike/sportbikes/2014/s1000rr/s1000rr_overview.html
[7] http://www.ducati.com.au/bikes/superbike/899_panigale/index.do
[8] https://www.kawasaki.com/Products/2015-Ninja-ZX-10R-ABS
[9] http://www.yamaha-motor.com.au/promotions/motorcycle/all-new-yamaha-yzf-r1
[10] http://motorcycles.honda.com.au/Supersports/CBR1000RR/ABS
[11] http://www.suzukimotorcycles.com.au/range/road/supersport/gsx-r1000-abs
[12] http://www.yamaha-motor.com.au/promotions/motorcycle/all-new-yamaha-yzf-r1
[13] https://motorcycle.honda.ca/honda-advantage/motorcycle
[14] http://world.honda.com/motorcycle-technology/brake/p4.html

Component suppliers such as Bosch and Continental have made ABS systems available for an increasing range of motorcycle types and markets, including those sized 125 cc and below. In 2016, a Bosch-marketed system weighs under 500g and is described as a cost-effective solution for the price-sensitive small motorcycle segment. According to Bosch[15]:

> *"As well as optimizing size and weight, Bosch focused on reducing costs. As a result, the [ABS10] system is suitable for use in small motorcycles with up to 250cc displacement – a segment that is both price-sensitive and popular in emerging markets. We are bringing our ABS technology to all vehicle classes and markets."*

The FCAI recently surveyed its members on motorcycle ABS fitment rates and advise that approximately 80 per cent of new road motorcycles delivered to the market in Australia at the end of 2015 had ABS fitted as standard. The FCAI represents manufacturers and importers of new motorcycles to Australia and advises that fitment has grown rapidly over the last few years, estimating 2007 fitment to new road motorcycles at around 30 per cent, 2013 fitment at around 60 per cent and 2015 and 2016 fitment at nearly 80 per cent.

Motorcycle manufacturers such as Aprilia and Honda, and component suppliers including Bosch market the benefits of CBS for smaller models of motorcycle. Honda, for example, promotes CBS as standard equipment on most of its production scooters and markets its ability to distribute a highly effective brake force balancing[16]:

> *"the Combined Brake System […] generates an ideal balance of braking control to both wheels to smoothly, easily and almost automatically achieve braking forces on par with the most expert riders, and all with only the simple squeeze of one hand".*

Honda fits CBS to scooters in the capacity range from 50 to 300 cc, and to small motorcycles.

2.5 Applicable International Standards

Australia participates in the peak UN forum that sets both the framework and technical requirements for international vehicle standards, known as WP.29[17]. The Australian Government has been involved for over thirty years and is a signatory to the two major treaties for the development of UN Regulations (the 1958 Agreement) and GTRs (the 1998 Agreement). The adoption of international regulations as a basis results in the highest safety levels at the lowest possible cost.

In relation to motorcycle braking systems two international regulations exist, both containing substantively the same requirements, UN Regulation No. 78 [Braking – category L vehicles] [27] and GTR No. 3 [Motorcycle brakes] [28]. Both regulations cover general motorcycle braking requirements and include performance and system requirements where ABS is fitted. The standards require that motorcycle braking systems meet a minimum level of performance in terms of deceleration, stopping distance, brake fade and performance when wet.

[15] http://www.bosch-presse.de/presseforum/details.htm?txtID=7444&locale=en
[16] http://world.honda.com/tech-views/motor/cbs/PCX/
[17] http://www.unece.org/trans/main/wp29/introduction.html

Motorcycles fitted with ABS in accordance with UN Regulation No. 78 are subject to a series of additional tests. The tests confirm ABS performance, including in the event of ABS electrical failure. The ABS test series comprises the following individual tests:

a. Stops on a high friction surface.
b. Stops on a low friction surface.
c. Wheel lock checks on high and low friction surfaces.
d. Wheel lock check - high to low friction surface transition.
e. Wheel lock check - low to high friction surface transition.
f. Stops with an ABS electrical failure.

Each test specifies necessary test conditions and the performance requirements to be achieved. With ABS fitted, brief periods of wheel locking or extreme wheel slip are allowed, provided that this does not affect the stability of the vehicle. Below speeds of 10 km/h wheel locking is permitted.

In addition to the above tests, UN Regulation No. 78 requires motorcycles equipped with an ABS system to be fitted with a yellow warning lamp that shall be activated whenever there is a malfunction that affects the generation or transmission of signals in the vehicle's ABS system.

Governments may refer to either the UN Regulation or GTR in national or regional legislation. The majority of contracting parties to the 1958 Agreement including 28 European Union (EU) member states, Japan, India, Taiwan and Brazil have announced mandates for the fitment of motorcycle ABS through UN Regulation No. 78. The United States (US) is not a signatory to UN regulations but is to GTRs and has adopted GTR No. 3[18] but has not at this stage set ABS as a mandatory requirement for motorcycles supplied into the US market. In the case of the European Commission (EC) that represents the countries of the EU, the mandate was introduced in 2012 via regional legislation (PE-CONS 52/12[19]) with phased-in implementation from January 2016 to 2017.

As noted above, through the ADRs Australia adopts UN Regulation No. 78 as its primary motorcycle braking regulation for new vehicles under ADR 33/00 – Brake Systems for Motorcycles and Mopeds. ADR 33 was introduced in 2006 and was last updated in 2007 to allow certification to the latest version of UN Regulation No. 78 and GTR No. 3.

2.6 The Predicted Market Response to Government Action

Internationally, motorcycle manufacturers and component suppliers have demonstrated the ability to increase the fitment of advanced braking systems such as ABS and CBS. This can be seen in the supply of new motorcycles to the EU and other significant markets that have such requirements.

The Australian market is likewise capable of increasing fitment of ABS/CBS to motorcycles. Upon examination of registration data, MUARC reported that around 20 per cent of all new

18 http://www.unece.org/fileadmin/DAM/trans/doc/2013/wp29/WP29-160-29e.pdf
19 http://register.consilium.europa.eu/doc/srv?l=EN&f=PE%2052%202012%20INIT

motorcycles (ADR category *LC* with engine capacity over 125 cc) sold in early 2015 (including registerable off-road models) were equipped with ABS. This was noted as a significant reduction from 2014. Under a business-as-usual scenario, MUARC predicts that by 2020 fitment would increase to around 75 per cent of all new registerable motorcycles. MUARC also estimated that in 2015 around 7 per cent of motorcycles in the entire registered Australian fleet (new and old) were fitted with ABS, which, with expected growth patterns was not likely to rise above 20 per cent by 2025.

The FCAI reported that in 2015 its members accounted for almost 94 per cent of all recorded motorcycles imported into Australia, of which 41 per cent were road motorcycles,35 per cent were off-road motorcycles, 19 per cent were 4-wheeled All-Terrain Vehicles (ATVs) and 5 per cent were scooters. At the end of 2015 FCAI surveyed its members on motorcycle ABS fitment rates and advised that approximately 80 per cent of new road motorcycles delivered to the market at that time had ABS fitted as standard. FCAI notes that this figure has grown rapidly over the last few years; estimated numbers in 2007 were 30 per cent, and in 2013 were 60 per cent and in 2016 has increased to nearly 80 per cent.

To be able to compare the FCAI new vehicle figures with the MUARC whole-fleet figures, the additional 35 per cent of non-road specific motorcycles (excluding ATVs and scooters) may be included to obtain an approximate FCAI whole new fleet fitment comparison rate of 43 per cent at the end of 2015. This figure does not account for fluctuations in the rate over the year, and does not incorporate non-member fitment rates. There are also a number of used motorcycles being imported, representing approximately 3 per cent of all motorcycles (new or used) supplied for road use in Australia, only 11 per cent of which were supplied with ABS.

MUARC modelled the projected impact of widespread adoption of advanced motorcycle braking systems in Australia. MUARC concluded that, depending on when it could be introduced, an ADR would lead to an additional 60 per cent reduction over current trends in death and injury crashes of motorcyclists. The benefits costs associated with increased fitment under several Government intervention options are discussed in more detail in Section 4.

2.7 Objective of Government Action

A general objective of the Australian Government is to ensure that the most appropriate measures for delivering safer vehicles to the Australian community are in place. The specific objective of this Regulation Impact Statement (RIS) is to examine the case for government intervention to increase the fitment of advanced braking systems to motorcycles supplied to Australia. This is in order to reduce the cost of road trauma to the community from motorcycle crashes.

Where intervention involves the use of regulation, the Agreement on Technical Barriers to Trade requires Australia to adopt international standards where they are available or imminent. Where the decision maker is the Australian Government's Cabinet, the Prime Minister, minister, statutory authority, board or other regulator, Australian Government RIS requirements apply. This is the case for this RIS. The requirements are set out in The Australian Government Guide to Regulation [42].

3 WHAT POLICY OPTIONS ARE BEING CONSIDERED?

A number of options were considered below to increase the fitment of advanced braking systems to motorcycles supplied to Australia. These included both non-regulatory and/or regulatory means such as the use of market forces, public education campaigns, codes of practice, fleet purchasing policies, as well as regulation through the ADRs.

3.1 Available Options

3.1.1 Non-Regulatory Options

Option 1 - no intervention
Allow market forces to provide a solution (no intervention).

Option 2 - user information campaigns
Information campaigns (suasion) to inform consumers about the benefits motorcycle ABS using:
a - targeted awareness; or,
b - advertising.

Option 3 - fleet purchasing policies
Permit only motorcycles fitted with advanced braking systems for government purchase (economic approach).

3.1.2 Regulatory Options

Option 4 - codes of practice
Allow motorcycle supplier associations, with government assistance, to initiate and monitor a voluntary code of practice for the fitment of motorcycle advanced braking systems. Alternatively, mandate a code of practice (regulatory—voluntary or mandatory).

Option 5 - mandatory standards under the Competition and Consumer (C&C) Act 2010.
Mandate standards for advanced braking systems under the C&C Act (regulatory—mandatory).

Option 6 - mandatory standards under the MVSA (regulation)
Mandate standards requiring the fitment of advanced braking systems to certain motorcycles under the MVSA based on UN Regulation No. 78 (regulatory—mandatory). Cases examined were:
a - Mandatory ABS for engine capacity above 125 cc and,
b - Mandatory ABS for engine capacity above 125 cc and ABS or CBS for engine above 50 cubic centimetres and engine capacity 125 cubic centimetres or below..

3.2 Discussion of the Options

3.2.1 Option 1 - No Intervention

The no intervention (business as usual or BAU) option relies on the market fixing the problem, the community accepting the problem, or some combination of the two.

In examining this case, the EC requirements on the fitment of motorcycle ABS in the EU countries and its flow on effect to the Australian market was considered. This included decreasing production costs of ABS equipment and the development of more compact and effective systems that are applicable to a widening variety of motorcycle types.

This option was analysed further in terms of expected benefits to the community, setting a baseline for comparison with the other options.

3.2.2 Option 2 - User Information Campaigns

User information campaigns can be used to promote the benefits of new technology and so encourage consumer demand. Campaigns may be carried out by the private sector, the public sector, or a combination of the two. They can be effective where the information being provided is simple to comprehend and unambiguous. They can be targeted towards the single consumer or to those who make significant purchase decisions, such as private or government fleet owners.

As discussed earlier in sections 1.3 and 2.1, there are already both government and industry initiatives in Australia to increase the fitment of motorcycle advanced braking systems in Australia. These include road user information and awareness campaigns, rider education, training and skills development schemes, safety equipment and technology promotion.

These consumer information programs are less of the star rating of a vehicle type, as associated with the Australasian New Car Assessment Program (ANCAP) program, and more about encouraging consumers to choose motorcycles with the best safety features. One reason an ANCAP approach would have limited usefulness is that it is heavily focussed on crashworthiness. There are no crashworthiness requirements anywhere in the world for motorcycles, as there is no enclosed structure available to absorb the forces of impact. Appendix 6 – *Awareness Campaigns* details two real examples of awareness campaigns; a broad high cost approach and a targeted low cost approach. The broad high cost approach cost \$6 million and provided a benefit-cost ratio of 5. The targeted low cost approach cost \$1 million and was run over a period of four months. It provided an effectiveness of 77 per cent. However, it is recognised that these figures are indicative only as the campaigns do not relate to ESC or automotive topics. It is likely that a campaign would have to be run on a continuous basis to maintain its effectiveness.

Appendix 7 – *Information Campaigns* details three notable automotive sector advertising campaigns for Hyundai, Mitsubishi and Volkswagen. The cost of such campaigns is not made public. However, a typical cost would be \$5 million for television, newspaper and magazine advertisements for a three-month campaign (*Average Advertising Costs* n.d.). Some recent research showed that for general goods, advertising campaigns can lead to an around 8 per cent increase in sales (Radio Ad Lab, 2005). This increase is similar to the result achieved by the Mitsubishi campaign promoting the benefits of its ESC. It is likely that a campaign would have to be run on a continuous basis to maintain its effectiveness. Appendix 7 – *Information Campaigns* also outlines other government and private sector campaigns. While some costs were available, the effectiveness of the campaigns was not able to be determined. Campaigns around automotive safety technologies do not need to consider manufacturer system development costs, because consumers are educated to choose from existing (developed) models that already include the technology.

Table 5 provides a summary of the costs and known effectiveness of the various information campaigns.

Table 5: Estimation of campaign costs and effectiveness

Campaigns	*Estimated cost ($m)*	*Expected effectiveness*
Awareness - broad	6	$5 benefit/$1 spent
Awareness – targeted *	1 per four month campaign, or 3 per year	Total of 77 % awareness and so sales (but no greater than existing sales if already more than 77%)
Advertising*	1.5 per month campaign, or 18 per year	8 % increase in existing sales.
Fleet	0.15	-
Other	0.2-0.3	-

* used in benefit-cost analysis (Section 4).

Targeted awareness campaigns (Option 2a) may include direct rider education, training and skills development schemes, safety equipment and technology promotion, as well as market incentives or promotions at point of sale. Such campaigns can be tailored to a specific user group. With the existing business as usual fitment rates expected for motorcycle advanced braking systems, it was determined that targeted awareness campaigns would have little residual effect after 6 years of campaign duration (Figure 11). This has been taken into account in the benefit-cost analyses.

Advertising campaigns (Option 2b) typically capitalise on media and event promotion of a technology, and may be less specific in effect than targeted awareness campaigns. They usually have a minor to moderate effect on technology uptake in comparison to targeted awareness campaigns, and may be more costly. A campaign promoting motorcycle safety may be run most advantageously over the prime annual motorcycle sales season, and its lead-in period. With the existing business as usual fitment rates expected for motorcycle advanced braking systems, it has been determined that targeted awareness campaigns would have a strongest effect over the early years of a policy lifespan and would retain a positive (although reducing) effect for the entire campaign duration (Figure 12). This has been taken into account in benefit cost analyses.

This option was analysed further in terms of expected benefits to the community.

3.2.3 Option 3 - Fleet Purchasing Policies

The government could intervene by permitting only motorcycles fitted with advanced braking systems to be purchased for its fleet. This would create an incentive for manufacturers to fit these systems to models that are otherwise compatible with government requirements.

However, as the government fleet is made up of less than 0.25 per cent motorcycles [43], fleet purchasing policies are not considered an effective means to increase the penetration of advanced braking systems more generally in the Australian fleet.

This option was not considered further.

3.2.4 Option 4 - Codes of Practice

A code of practice can be either voluntary or mandatory. There can be remedies for those who suffer loss or damage due to a supplier contravening the code, including injunctions, damages, orders for corrective advertising and refusing enforcement of contractual terms.

Voluntary Code of Practice

Compared with legislated requirements, voluntary codes of practice usually involve a high degree of industry participation, as well as a greater responsiveness to change when needed. For them to succeed, the relationship between business, government and consumer representatives should be collaborative so that all parties have ownership of, and commitment to, the arrangements (Commonwealth Interdepartmental Committee on Quasi Regulation, 1997).

In the case of motorcycle ABS and CBS, the similarity in performance of many systems means that variations in quality across suppliers is not as critical as whether it is fitted. This means it would be somewhat easier to quantify and detect a ‘breach’ of a code that specifies fitment rates rather than performance capability. Nevertheless, recourse for any breaches of and agreed level of fitment in a voluntary code would be difficult to control either by the manufacturers’/importers’ associations or by governments. In the case of motorcycle ABS and CBS, the consequences of a breach would be serious in terms of road deaths and injuries of motorcyclists as well as the dollar costs to the broader community, while suppliers responsible for such breaches would not face direct recourse.

A voluntary code of practice could be an agreement by industry to fit ABS and CBS to motorcycles at nominated fitment rates. Of the manufacturers and importers supplying new motorcycles, the FCAI represents 94 per cent of sales volumes. Suppliers representing the remaining, yet significant, 6 per cent of supplied Australian motorcycles are numerous and it would be difficult securing and monitoring an agreement with all parties. The Department's Road Vehicle Certification System (RVCS) listed 57 active motorcycle suppliers/brands between 2013 and 2016, around a quarter of which were FCAI members.

It is clear that for safety critical issues such as advanced braking systems, voluntary codes of practice are a high risk and cost proposition in terms of both monitoring and detecting breaches and being able to take timely action to intervene.

Due to the above reasons, this Option 4 sub-option was not considered further.

Mandatory Code of Practice

Mandatory codes of practice can be an effective means of regulation in areas where government agencies do not have the expertise or resources to monitor compliance. However, in considering the options for regulating the performance of road vehicles, the responsible government agency (Department of Infrastructure and Regional Development) has existing legislation, expertise, resources and well-established systems to administer a compliance regime that would be more effective than a mandatory code of practice.

Because of the above, this Option 4 sub-option was not considered further.

3.2.5 Option 5 - Mandatory Standards under the C&C Act

As with codes of practice, standards can either be voluntary or mandatory as provided for under the C&C Act.

However, in the same way as a mandatory code of practice was considered in the more general case of regulating the performance of road vehicles, the responsible government agency (Department of Infrastructure and Regional Development) has existing legislation, expertise and resources to administer a compliance regime that would be more effective than a mandatory standard administered through the C&C Act.

For this reason, Option 5 was not considered further.

3.2.6 Option 6 - Mandatory Standards under the MVSA

Under Option 6, the Australian Government would mandate fitment of ABS/CBS to motorcycles supplied to the market via an amendment to the national standard for motorcycle braking, ADR 33. The technical requirements of UN Regulation No. 78, incorporating up to the latest /03 series of amendments would be implemented through the ADR for all applicable vehicles. This would also include a requirement that ABS/CBS be fitted as prescribed.

As this option is considered viable, and has been pursued internationally, the introduction of mandatory standards was analysed further in terms of expected benefits to the community.

Background

Australia mandates approximately sixty ADRs under the MVSA. Vehicles are approved on a model (or vehicle type) basis known as type approval, whereby the Australian Government approves the design of a vehicle type based on test and other information supplied by the manufacturer and/or type approval authorities. Compliance of vehicles built according to a granted approval is ensured by the audit of the manufacturer's production facilities and processes.

A program of harmonising the ADRs with international standards, as developed through the UN, began in the mid-1980s and has recently been accelerated. Harmonising with UN requirements provides consumers with access to vehicles meeting the latest levels of safety and innovation, at the lowest possible cost. The Australian Government has the skill and experience to adopt, whether by acceptance as alternative standards or by mandating, both UN GTRs and UN regulations into the ADRs.

In relation to motorcycle braking systems, including ABS and CBS, two international regulations exist, both containing substantively the same requirements: UN Regulation No.78 [Braking – category L vehicles]; and, GTR No. 3 [Motorcycle brakes]. Both regulations cover general motorcycle braking requirements and include performance and system requirements where ABS or CBS is fitted. It is left up to each country to mandate the actual fitment of ABS or CBS when calling up either of these regulations into national or regional legislation.

As discussed earlier, through the ADRs Australia adopts UN Regulation No. 78 as its primary motorcycle braking regulation for new vehicles under ADR 33/00 – Brake Systems for Motorcycles and Mopeds. The majority of contracting parties to the 1958 Agreement including the 28 EU member states, Japan, India, Taiwan and Brazil have announced mandates for the fitment of motorcycle ABS through UN Regulation No. 78.

Scope

If advanced braking systems were to be mandated for motorcycles supplied to Australia, consideration would be given to harmonising as much as possible with international standards, where available. If international standards are not available, the next consideration would be to harmonise with major markets. In this case, while the performance requirements for ABS/CBS are fully set out in UN Regulation No. 78, the applicable motorcycle categories for any requirement for fitting ABS/CBS are not covered. Therefore, they would be aligned to the EU market requirements as detailed in EC legislation. The EU is not only a major market in the world but it is also the most closely aligned to the suite of available UN regulations.

Adopting the existing EC requirements mean that manufacturers are already producing and supplying motorcycles with ABS/CBS as prescribed by EC legislation that are also compliant with UN Regulation No. 78. Adopting the same standards would not add unique requirements (barriers to trade) in the supply of motorcycles to the Australian market. This is because it avoids the manufacturer development costs otherwise required to produce a motorcycle braking system just for Australia.

The EC allows some exemptions for specific motorcycle types – for example, three wheeled vehicles, small two-wheeled vehicles with a reduced capability (such as limited battery capability and/or economical factors) to support ABS/CBS, and vehicles designed for off-road use (*enduro* and *trials* motorcycles). Notably, the EC legislation exempts many popular off-road type *enduro* motorcycles (typically light motorcycles with single seat) with the exception of dual-purpose on/off-road motorcycle types (typically heavier or more powerful and capable of high on-road speeds and/or carrying pillion passengers).

The EC requirements are as follows:

a) new motorcycles of the L3e-A1 subcategory are to be equipped with either ABS or a CBS or both types of advanced brake systems, at the choice of the vehicle manufacturer;

b) new motorcycles of subcategories L3e-A2 and L3e-A3 are to be equipped with ABS. However; L3e-AxE (x = 1, 2 or 3, two-wheel *enduro* motorcycles) and L3e- AxT (x = 1, 2 or 3, two-wheel *trial* motorcycles) are exempt.

Definitions of exempted EC classes (*enduro* and *trial* motorcycles) are as follows:

L3e-AxE (x = 1, 2 or 3) *enduro* motorcycles:

> (a) seat height ≥ 900 mm and (b) ground clearance ≥ 310 mm and (c) overall gear ratio in highest gear (primary gear ratio × secondary gear ratio in the highest speed × final drive ratio) ≥ 6.0 and (d) mass in running order plus the mass of the propulsion battery in case of electric or hybrid electric propulsion ≤ 140 kg and (e) no seating position for a passenger.

L3e-AxT (x = 1, 2 or 3) *trial* motorcycles:

> (a) seat height ≤ 700 mm and (b) ground clearance ≥ 280 mm and (c) fuel tank capacity ≤ 4 litres and (d) overall gear ratio in highest gear (primary gear ratio × secondary gear ratio in the highest speed × final drive ratio) ≥ 7.5 and (e) mass in running order ≤ 100 kg and (f) no seating position for a passenger.

In prescribing these requirements, the EC found that a mandate to fit ABS to all new motorcycles supplied to its member nations offered the greatest net benefit based on its benefit-cost analyses. However, after consultation with industry, a compromise option was allowed that permitted CBS for motorcycles with less than 125 cc (or equivalent as per EC requirements). A summary of applicability is shown in 5.

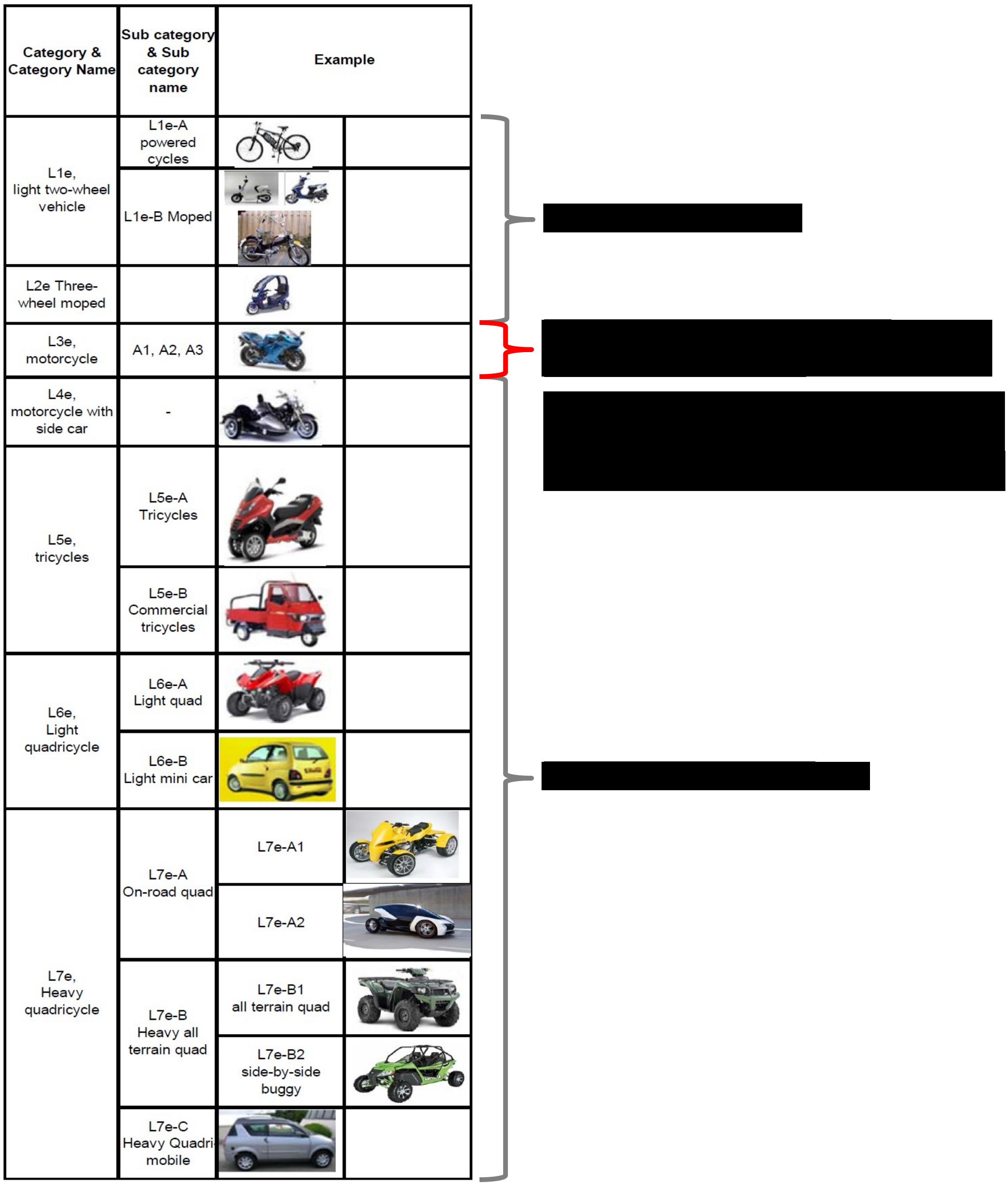

Figure 5: EC mandate for advanced braking systems for motorcycle, on-road classes (source: EC PRES-12-519)

A corresponding compromise regarding advanced braking systems for the supply of smaller (low power) motorcycles was considered for Australia. In Australia, growth in the motorcycle sector comprises significant numbers of smaller vehicles that are often marketed towards (and generally seen as attractive by) young and/or inexperienced riders. These more vulnerable, inexperienced riders may benefit substantially from safety interventions such as advanced braking systems. The effectiveness of advanced braking systems against trauma for inexperienced riders is considered to be greater than for experienced riders. These conditions, and the fact that crash trauma severity is the same regardless of motorcycle size or rider experience, mean it is equally important to prescribe safety interventions for low power Australian motorcycles.

General updating of ADR 33 Performance Requirements

Under ADR 33/00 – Brake Systems for Motorcycles and Mopeds, Australia currently adopts the technical requirements of UN Regulation No. 78 as its primary motorcycle braking regulation for vehicles supplied for use on Australian roads. ADR 33 allows certification to the latest version of UN Regulation No. 78 in force (series /03) and GTR No. 3.

However, ADR 33/00 also allows for a motorcycle to meet an older set of performance criteria that is not internationally harmonised (contained within its Appendix B) and which includes only basic requirements to be met if ABS is fitted.

In 2015 no manufacturers/importers applied for approval of ABS equipped motorcycle braking systems via ADR 33/00 Appendix B. As part of this current review, it is proposed that the ADR be fully aligned with UN Regulation No. 78 /GTR No.3 by the removal of the Appendix B option. This would not only prevent any reversion back to reduced braking performance more generally, but would ensure that ABS if mandated would meet modern internationally based safety requirements.

The base standard to be applied via a new ADR 33/01 would therefore be UN Regulation No. 78 series /03 for category LC motorcycles, while ADR 33/00 would continue as an acceptable alternative standard for categories LA, LB, LD and LE vehicles (trikes and small mopeds).

In line with an FCAI request (see below), disablement of ABS (such as an on/off switch) for off-road use would be permitted for LC category adventure-tourer motorcycles designed for use on dirt tracks and unformed roads (fitted with tyres appropriate for use on those surfaces). This would be built into the ADR (UN Regulation No. 78 series /03 is silent on the issue) and would also be allowed if UN Regulation No. 78 series /04 (currently under development) becomes available as a further alternative (UN Regulation No. 78 series /04 is explicit about disabling ABS by requiring re-enabling upon vehicle start-up. It also sets requirements for tell-tales to signal ABS disablement).

Industry Positions

Regarding technical requirements for the performance of ABS systems, the FCAI has advised that if ABS were to be mandated for motorcycles, it would encourage the Australian government to “align substantially with the EU requirements”; ie, adopt the technical requirements in UN Regulation No. 78 as well as an application scope similar to that of the EC.

In terms of the application scope, the FCAI has suggested that the motorcycle sector in Australia may benefit from additional concessions beyond those outlined in the EC requirements. Agricultural motorcycles (commonly referred to as ‘Ag bikes’) that are generally used in and around rural or farm properties in Australia, are primarily used off-road but may be registered for on-road use. Because the ground clearance of such motorcycles is typically lower than required for the EC '*enduro*' exemption, affected Australian Ag bikes would normally require ABS/CBS under any similar requirements. Other necessary criteria, such as suspension travel, gear ratio and pillion capability, may also mean that such motorcycles would not be exempt.

However, it would be difficult to exactly identify Ag bikes through the ADR system in order to apply any explicit exemption. Ag bikes represent a small and diminishing proportion of new motorcycles supplied to Australia. It is anticipated that manufacturers could instead make minor adjustments (ground clearance, suspension, etc) to these types of motorcycles, at little or no extra cost, that would make them exempt - without detracting from their primary role (off-road).

The FCAI has also proposed a means for riders to temporarily disable ABS (such as an on/off switch) for off-road use of adventure-tourer type motorcycles, where it defines off-road as "either dirt tracks or unformed surfaces". While modern systems are becoming increasingly sophisticated and are better able to operate on a variety of surfaces, some experienced adventure-tourer riders have argued that they would benefit from being able to temporarily deactivate ABS.

4 WHAT IS THE LIKELY NET BENEFIT OF EACH OPTION?

Each of the policy options considered aims to increase the fitment of advanced braking systems to motorcycles. For the analysis it was assumed that once fitted, the systems under any of the options would have the same minimum level of safety performance. This is a very conservative approach as in reality this would only be the case under Option 6 - mandatory standards under the MVSA (regulation). This is because, unlike the other options, there is a standard being considered under Option 6 and this contains minimum safety performance requirements. The assumption means that the effect of each policy option in terms of costs and benefits is purely a function of the fitment rate of the technology.

There has been a substantial amount of international and domestic research into the costs and benefits of motorcycle ABS and CBS. This includes studies of crash data, field trials, benefit-cost analyses and an extensive amount of industry consultation. A chronological review of this research was carried out. The review concentrated on the cost, effectiveness and impact of advanced braking systems. These were fundamental in quantifying the benefits and costs associated with each policy option.

These parameters were combined with Australian specific motorcycle data for sales and crashes, in order to establish a benefit-cost analysis for each viable option that is directly relevant to Australia. A sensitivity analysis was also conducted, to test the effect of variation in the parameters and so be conservative in the final results.

4.1 Review of Advanced Motorcycle Braking Literature

4.1.1 Effectiveness and Impact

International Research

The performance of early and developing variations of motorcycle ABS was first reported around 20 years ago. In 1998 a study by McCarthy [44] investigated the effect of ABS available at that time on BMW motorcycle accidents. The study was inconclusive due to the small sample size of ABS related accidents. A subsequent report by McCarthy in 1999 achieved a larger sample size and found that casualties from motorcycles fitted with the early ABS technology of the era that were fatal or serious were an average 3 per cent lower [45]. McCarthy also found that the proportion of impacts to the front of the motorcycle was 8 per cent lower for motorcycles fitted with ABS and that the proportion of casualties on ABS-equipped motorcycles in accidents at or near road junctions was about 2 per cent lower than for those on unequipped machines.

In 2000 Sporner and Kramlich [46] analysed 610 accidents to determine that in 65 per cent of all accidents between motorcycles and cars, the motorcycle rider was able to brake before the collision. In 19 per cent of these cases the rider fell off before the collision. It was concluded that about 55 per cent of crashes could be positively influenced by motorcycle ABS.

In 2001 an ETSC report [47] affirmed this research and stated that ABS technology available at that time could reduce motorcycle trauma by at least 10 per cent. The ETSC recommended that ABS should be mandatory for motorcycles as a high legislative priority.

In 2004 Gwehenbereg [48] analysed 200 serious crashes, finding that ABS stabilises the braking process, shortens the braking distance and prevents the front wheel from over-braking, thus preventing dangerous falls whilst braking. It was reported that ABS alleviates cognitive-intensive skill required for effective motorcycle braking, particularly for sustaining braking manoeuvres at the tractive limit and during emergency braking. It was predicted that ABS could avoid up to 17 per cent of all serious motorcycle crashes. The report considered that training may facilitate riders to utilise the maximum advantages of ABS.

In 2005, a study for the Austrian Road Safety Board [49], examined how ABS improves brake handling of the average motorcycle rider in an emergency braking manoeuvre. Participants of the study included both new license holders and experienced riders, taken to be representative of the Austrian riding population. The study found that for motorcycles not equipped with ABS experienced motorcycle riders achieved an average braking deceleration of about 6.6 ms^2 while novices, after six hours of training, achieved an average of 5.7 ms^2. After an introduction to ABS and a few minutes of practice, experienced riders were able to achieve an average deceleration of 7.8 ms^2 and novices an average of 7.7 ms^2 when using a motorcycle equipped with ABS. The report also stated that riders of motorcycles fitted with ABS are able to improve their brake performance immediately, particularly after receiving instructions on ABS use. The report recommended that ABS should be mandatory motorcycle equipment.

From 2005 to 2007 the International Motorcycle Manufacturers Association (IMMA) simulated almost 2000 US and European motorcycle crash cases from 1981 (Europe) and 2004 (US) data sets, finding a positive net effect from ABS versions available at that time [50]. However, it was concluded that at that time the benefit-cost ratio of fitment of ABS motorcycles may have been lower than other safety interventions for other vehicle types in those specific regions. It should be noted that the performance and applicability of motorcycle ABS has progressed significantly since the 1980s.

In 2006, the US National Highway Transport Safety Administration (NHTSA) reported an average reduction in motorcycle stopping distance of 5 per cent attributable to ABS technology of the period [41].

In 2007, Baum [51] conducted a benefit-cost analysis on ABS in motorcycle downfall crashes. The study only considered that ABS would be effective if the rider fell off the motorcycle during braking prior to collision. The effectiveness of motorcycle ABS in downfall crashes was estimated at 85 per cent. It was also estimated that a rider is twice as likely to be fatally injured in a downfall rather than a non-downfall accident. Benefit-cost ratios for two effectiveness levels were calculated; low and high. Low effectiveness only assessed the potential for injury mitigation for fatally injured riders in downfall accidents. The low effectiveness assessment assumed that ABS is 85 per cent effective at preventing downfall crashes, with the casualty injury level being reduced from a fatal to a serious. The high effectiveness scenario considered the avoidance of accidents. It was assumed that fatalities, severe injuries and slight injuries were reduced to non-injured in the relevant group of crashes (those with downfall). The authors stated that both of these scenarios underestimated the effectiveness of ABS because it was not possible to assess the implications of the reduction in impact speed that ABS could provide. The high effectiveness scenario was stated to be more realistic because it considered a wider range of casualty severities than the low effectiveness scenario. The benefit to cost ratio for the high effectiveness system was estimated to be between 4.6 and 4.9, while the benefit to cost ratio for the low effectiveness system was estimated to be between 1.7 and 1.8.

Also in 2007, a Bosch study on German data reported that motorcycle ABS technology available at that time reduced motorcycle trauma by 26 per cent and in general reduced speed in collisions by 31 per cent [52].

In 2008, IMMA commissioned a supplementary benefit-cost analysis conducted by Kebschull and Zeller of Dynamic Research Inc [50]. The analysis only considered that ABS would be effective if the rider fell off the motorcycle. It did not consider that ABS could provide a benefit in crashes where the limit of braking had not been evidentially achieved. It included motorcycle and moped data from European accidents using crash data collected between 2000 and 2004 (MAIDS 2 - data from five countries: Spain, Italy, Germany, France and Holland) and from US accidents using crash data from Hurt et al (1981). 921 European and 900 American motorcycle crashes were simulated, each with and without ABS fitted to the motorcycle. Three ABS configurations were examined; front ABS only, rear ABS only and independent front and rear ABS. The study found that when only a rider falling off was considered, all types of ABS had low effectiveness and had costs much higher than for the other low effectiveness vehicle safety measures. This lead to the report determining that ABS was not as cost effective as other safety measures.

In 2008 a European study by Federal Highway Research Institute reported a 12 per cent reduction in downfall accident trauma associated with motorcycle ABS of the period [52]. Also in 2008 an Insurance Institute for Highway Safety (IIHS) study reported a motorcycle ABS effectiveness against trauma of 34 per cent in the US [52].

In 2009 Smith et al. [53] compared the potential influence of a wide range of active safety systems for motorcycles. Preventing wheel lock using ABS was ranked number 6 from a list of 43 wide-ranging functional requirements which were not adjusted for technical feasibility. The analysis sample was small and consisted of crashes of all severities.

In 2009 Continental reported trauma reductions of 23 per cent (front wheel ABS) to 53 per cent (both wheels) via motorcycle ABS, and a Swedish-led study reported European trauma reductions of up to 42 per cent [52].

In 2009, Rizzi et al. [54] examined Swedish motorcycle crashes and reasoning that head-on crashes were not strongly affected by the presence of ABS, used these as part of an induced exposure measure in a larger set of crashes consisting of police reported crashes matched to hospital records. The authors estimated that ABS was associated with a reduction of 38 percent of all crashes with injuries and 48 percent for all severe and fatal crashes.

In 2009 Robinson et al. [40] from UK Transport Research Laboratory (TRL) were commissioned by the EC to conduct a benefit-cost analysis for motorcycle advanced braking systems. Effectiveness estimates for motorcycle ABS and CBS were reviewed from literature. ABS was determined to be up to 36 per cent effective for some types of crashes, and CBS up to 26 per cent. The study also looked at the relationship between maximum engine power and accident risk but was not able to establish a direct link. The mandatory fitment of advanced braking systems was predicted to have significant long term benefits in terms of casualty reduction, and to have a positive benefit to cost ratio over the short to medium term. Over the long term, returns were estimated to fall between 3.5 and 5.6 times investment. A mandate for ABS for all motorcycles was recommended, with a compromise position considered for CBS for small motorcycles and mopeds (<125cc). The compromise position was adopted and enforced by the EC.

In 2010, Teoh et al. [55] from IIHS evaluated the effect of ABS on fatal crash rates per US registrations of motorcycles, comparing identical models with and without ABS from 2003 to 2008. Models fitted with ABS were found to be involved in 37 per cent fewer fatal crashes than non-ABS models. In 2013 the study was revisited to include an expanded sample size of 10,000 motorcycle crashes over 2003-2011 [56]. The same result was obtained.

In 2012, the NHTSA wrote that [57] “Using a case-control comparison methodology for motorcycles with and without ABS, and using two sets of data (fatal crashes and, separately, all police-reported crashes), we did not find statistically-significant results to suggest that ABS affects motorcycle crash risk”. However, the NHTSA also flagged that the results must be “treated with caution because of the small number of control-group motorcycle crashes available for the study”. The NHTSA also reported that the 2012 finding considered only 54 fatal ABS equipped motorcycle crashes that occurred between 2001 and 2008, and that all motorcycles involved were manufactured before 2008-9. The NHTSA does not appear to have continued with this line of research using a larger sample size. At the time, it findings on effectiveness were criticised by the US Highway Loss Data Institute (HLDI) and IIHS and were not supported by the international research discussed earlier (in particular, by the 2009 European commissioned TRL report). The findings were also analysed in detail and discounted by the Australian 2015 MUARC result. This gives greater credibility to the more recent effectiveness results following below, each of which incorporated a much larger sample size with statistically significant data sets.

In 2013, a Bosch study found that motorcycle ABS had been 33 per cent effective in crash reduction in India [58]. ABS additionally reduced the speed of impact in a further 16 per cent of accidents.

In 2013, a HLDI study reported an effectiveness of 20 per cent in the US [59].

In 2014 Rizzi et al. [60] conducted an international study into ABS effectiveness. Though previous research focused on large displacement motorcycles, the study used police data from Spain (2006-2009), Italy (2009), and Sweden (2003-2012) to analyse a range of motorcycles and scooters across Europe. The effectiveness of motorcycle ABS in reducing injury crashes ranged from 24 per cent in Italy and 29 per cent in Spain to 34 per cent in Sweden. The reductions in severe and fatal crashes were 34 per cent in Spain and 42 per cent in Sweden. The reduction in crashes involving scooters (at least 250 cc) attributed to ABS was 27 per cent in Italy and 22 per cent in Spain. In Spain, ABS on scooters with 250 cc displacement and above showed a reduction in severe and fatal crashes by 31 per cent.

A Bosch survey[20] presented online in 2015 highlighted recent global consistency in research findings regarding the effectiveness of motorcycle ABS against trauma. Furthermore, over the last decade the trend among research findings exhibits increases in the reported effectiveness, likely attributed in part to contemporary investments and advances in the technology among manufacturers and technology developers.

Australian Research

In 2006, Bayly et al. [61] conducted a broad investigation on intelligent transport systems and emerging technologies for motorcycle safety systems that have the potential to enhance motorcycle rider safety in Australia. Each technology was ranked on a prioritised list. Systems which addressed stability and braking were given the highest priority due to their potential to enhance motorcycle safety in almost all crash situations.

In a 2011 analysis of crash data to estimate the benefits of emerging vehicle technologies [62] funded by the Queensland Department of Transport and Main Roads and the Commonwealth Department of Infrastructure and Regional Development, the Centre for Automotive Safety Research (CASR) at the University of Adelaide estimated a benefit cost ratio of 27 for motorcycle ABS. This was the highest ratio of all analysed technologies for any road vehicle type. Widespread fitment of motorcycle ABS was projected to save over $795 million (2006 value). Estimates were developed using a cost of fitment varying by brand in the range from $500 to $2,000 per motorcycle.

Item 16c of the NRSS 2011-2020 listed consideration of ABS for motorcycles as an initiative to improve safety regulations for new vehicles. This was subsequently prioritised for consideration under item 7 of the National Road Safety Action Plan 2015-17. Consideration of the case for a mandate for motorcycle advanced braking systems was scheduled for the period 2015-2017. Accordingly, and as outlined in section 2.2, from 2014 the Department of Infrastructure and Regional Development and Vicroads jointly commissioned MUARC to report on the benefits and effectiveness of motorcycle ABS in the Australian context.

In 2015, MUARC released research that utilised an internationally adopted induced exposure methodology to quantify the benefits of ABS within the Australian context [37]. In doing so it reported on the real-world effectiveness of motorcycle ABS in Australia with a high degree of accuracy. The 'induced exposure' methodology analysed over 100,000 Australian motorcycle trauma crashes from five states. The induced exposure methodology determines the effectiveness of the underlying technology itself, eliminating confounding factors such as rider behaviours, styles and experience, and differences in distances travelled and types of motorcycles.

MUARC found that the results from European studies translated across to Australia with good coherence. MUARC reported that in Australia, 93 per cent of motorcycle crash types would benefit from ABS. When fitted to a motorcycle, ABS would be 33 per cent effective in reducing injury crashes and 39 per cent effective in reducing serious and fatal motorcycle crashes (Table 1).

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[20] http://www.bosch-motorcycle.com/media/ubk_zweiraeder/related_content/downloads/Motorcycle_ABS_effectiveness.jpg

The MUARC research modelled the projected impact of widespread adoption of motorcycle ABS in Australia. MUARC concluded that, depending on when it could be introduced, a mandate could lead to an additional 60 per cent reduction over current trends in death and injury motorcycle crashes.

4.1.2 Cost of Fitment

Kebschull and Zellner [50] estimated that a full ABS system costs EUR 539. This was based on information showing retail costs of EUR 350 for a Yamaha (2008) ABS system, and between EUR 635 and 822 for BMW systems.

Baum et al. [51] used much lower manufacturer costs of EUR 150 instead of end user costs in its reports.

Robinson et al. [40] determined the 'business as usual' costs of fitment of ABS to be EUR 150 to 822, and CBS EUR 75 to 400. That is, the range of costs of CBS is approximately half of that of ABS fitment. They also noted that information from industry indicated that in the case of mandatory fitment of advanced braking systems (ABS and CBS), increased demand would lead to reduction in price, both to the manufacturer and to the consumer. They estimated ABS cost would reduce to range EUR 100 to 200, and CBS to EUR 75 to 200 (less influence of economies of scale for CBS) after introduction of a European mandate.

In its 2015 study, MUARC referred to the European benefit-cost analysis used to mandate fitment of ABS on motorcycles 125 cc and above, noting that the figure used of EUR 500 per motorcycle was based on manufacturers' point of sale pricing. MUARC reported some stakeholders argued that suppliers' figures (based on what the cost to manufacturers would actually be by suppliers) of EUR 150 were more realistic. MUARC adopted the view that the typical cost to manufacturers for fitment of ABS technology on 125cc and larger motorcycles would be EUR 150 (approximately AU$ 220).

4.2 Benefit-Cost Analysis

The benefit-cost analysis model used in this analysis is the Net Present Value (NPV) model. Using this model, the flow of benefits and costs are reduced to one specific moment in time. The time period for which benefits are assumed to be generated is over the life of the vehicle(s). Net benefits indicate whether the returns (benefits) on a project outweigh the resources outlaid (costs) and indicate what, if any, this difference is. Benefit-cost ratios (BCRs) are a measure of efficiency of the project. For net benefits to be positive, this ratio must be greater than one. A higher BCR in turn means that for a given cost, the benefits are paid back many times over (the cost is multiplied by the BCR). For example, if a project costs $1 million but results in benefits of $3 million, the net benefit would be 3-1 = $2 million and the BCR would be 3/1 = 3.

Three of the policy options outlined in Section 3.2 of this RIS (Option 1 - no intervention; Option 2 - campaigns (containing two sub-options); and Option 6: mandatory standards under the MVSA (regulation) (containing two sub-options)) were considered viable and analysed further. The results of each option was compared with what would happen if there was no intervention (business as usual), that is, Option 1 - no intervention.

In the case of modelling the fitment of advanced braking systems to a motorcycle, there would be an upfront cost to the manufacturer/consumer incurred when the system is fitted, as well as in accommodating the design of the motorcycle to support system components. Once in use, there would be a series of benefits spread throughout the life of the motorcycles as the costs of crashes are reduced. This pattern would be repeated as new motorcycles are registered year after year and old motorcycles leave the fleet. There may also be other ongoing business and government costs over time, depending on the option being considered.

Period of analysis

The overall period of analysis would be the expected life of the policy option plus the time it takes for any benefits to work their way through the Australian fleet of motorcycles.

In this case the period of analysis covers 15 years of intervention (after which it is assumed the policy would be reviewed), plus the maximum lifespan of a motorcycle. The crash rate per vehicle age is known for Australian motorcycles aged up to 30 years (which is close to the maximum life of a motorcycle). This means that it would be possible to analyse the fleet effects for a full 30 years beyond the first 15 years of policy operation, when the last cohort of new motorcycles fitted with advanced braking systems are realising their benefits. However, a total of 45 years is a speculatively long analysis period. It was instead decided to analyse the benefits and costs for up to 20 additional years only. The total benefit-cost analysis period was therefore 15+20 = 35 years past the beginning of intervention. This period covers the most significant and accurately modelled effects of intervention. It is important to note that this would be conservative, as it would count the costs of fitting ABS to the last part of the fleet before the policy is reviewed, but not its associated benefits.

4.2.1 Benefit-Cost Parameters

ABS and CBS Effectiveness Values

As detailed earlier, there is a large body of research both internationally and domestically that concludes ABS is effective in reducing motorcyclist deaths and injuries. The most recent and highly relevant of these is the research commissioned by the Australian Government and Vicroads that was conducted by MUARC in 2015, as set out earlier in sections 2.2.1 and 4.1.1.

In it, MUARC determined that motorcycle ABS was 39 per cent effective against Australian motorcyclist fatalities and serious injuries. For all injury types (including minor), the effectiveness was determined to be 33 per cent. These values for Australia broadly align with later international findings and show that contemporary motorcycle ABS offers significant performance benefits over pre-2007 designs (such as those studied by IMMA in determining the net-positive European benefit-cost ratios).

The MUARC research predominantly analysed crash records for motorcycles capacity 125cc or greater. Less data was available to examine ABS/CBS effectiveness for smaller Australian motorcycles and scooters. As available Australian data does show good alignment with international data, the international values were adopted to represent these smaller vehicles.

TRL [40] considered that the benefits of advanced braking systems were lower for mopeds and scooters in Europe, generally due to the types of crashes that they are involved in and lower average travel speeds. This may not be the case in Australia where trauma severity has been shown to be independent of motorcycle type and size [40, 63]. Furthermore, in Australia it is predominantly inexperienced (often young) riders that crash on scooters and small motorcycles. Inexperienced Australian riders may benefit most from ABS and CBS because it tends to bring their braking performance towards that of an experienced rider. Therefore it could be the case that ABS and CBS effectiveness for motorcycles under 125 cc capacity is in reality equivalent to or greater than effectiveness for larger capacity motorcycles in Australia.

However, to be conservative, this RIS used the TRL figure for European CBS effectiveness against trauma of up to 26 per cent [53, 40]. Also conservatively, it did not use a higher CBS effectiveness figure against fatalities. With this approach, the RIS conservatively adopted *worst case* values for Australian CBS effectiveness. RIS effectiveness parameters for Australian motorcycle ABS and CBS are summarised in Table 6: Analysis parameters for motorcycle ABS and CBS effectiveness.

Table 6: Analysis parameters for motorcycle ABS and CBS effectiveness

Crash type	Effectiveness
ABS - fatalities & serious injuries	39%
ABS - all injuries	33%
CBS - all injuries	26%

Sales of New Motorcycles

The MUARC research contained Australian sales data and predicted sale trends for motorcycles (ADR Category LC) of capacity 125cc or greater. This was used as a basis for all options being considered in the RIS.

In addition, the FCAI established that around 5 per cent of the Australian fleet are scooters (ADR category LA or LC, depending on engine size). For Option 6a, due to the sale of scooters with capacity 125 cc or greater which would not be exempt from fitting ABS under requirements matching the EC's, some applicable sales could have been added (around 3 per cent). However, some sales would be subtracted (around 2 per cent) to match the European exemption for small capacity motorcycles of less than 125 cc. These factors largely cancelled out, leaving around a 1 per cent increase in sales above the MUARC LC road motorcycle sales data. Assuming a possible error margin in FCAI sales reporting data of around 1 per cent, it was decided that the combined effect of large scooters and small motorcycles on total applicable motorcycle sales was negligible. This also took a conservative position because it will be shown later in the sensitivity analysis that decreasing sales (and forecast sales) by around 1 per cent reduces the resultant net benefit and the benefit cost ratio.

For Option 6b only, a larger set of vehicles sales was analysed. In addition to the set used for Option 6a, sales of scooters and road motorcycles with an engine capacity from 50 cc to 125cc were added. It was conservatively (generously) assumed that 5 per cent of total combined sales were of capacity under 125 cc and thereby eligible for a lower cost option of fitting CBS, and that (again conservatively) all such eligible vehicles would be fitted with the lower cost CBS option. As the sensitivity analysis will show later, increasing the presumed CBS eligibility above 5 per cent only increased the resultant net benefit and benefit-cost ratio. This is because CBS has a similar effectiveness as ABS in the small vehicle categories, but development and fitment costs are less (around half) that of ABS.

Finally, a conservative growth rate correction was applied to forecast sales data after 15 years, to align it with the BITRE forecast [4] that motorcycle growth is expected to average below 2 per cent per annum over the next 20 years. Forecast sales used for benefit-cost analysis are shown in Figure 6.

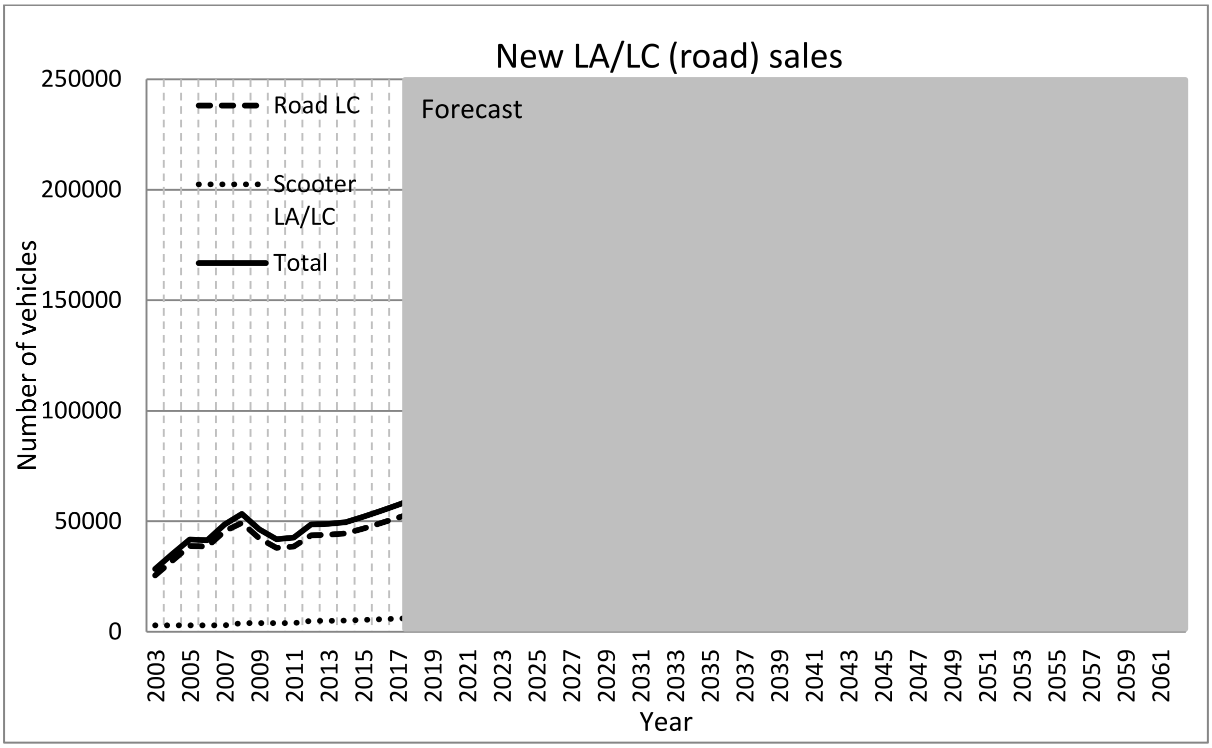

Figure 6: Forecast sales used for benefit-cost analysis

Current Fitment Rate

Based on examination of registration data, MUARC reported that around 20 per cent of all new motorcycles (ADR category *LC* with engine capacity over 125 cc, including road-registerable off-road capable models) sold in Australia in early 2015 were equipped with ABS. This was noted as a significant reduction from the 2014 rate. Under a business-as-usual scenario, MUARC predicted that by 2020 fitment would increase to around 75 per cent of all new motorcycles. In comparison, an earlier 2009 study by TRL [53] estimated that (in the absence of a mandate) by 2020 a maximum new motorcycle ABS or CBS fitment of 37 per cent would be taken up by European consumers, with 75 per cent of all models expected to be offered with ABS as an option.

Due to the differing estimates of new motorcycle fitment rates provided to the Department (MUARC 20 per cent, FCAI 43 per cent as described in section 2.6), all outcomes for a motorcycle fitment range from 30 to 50 per cent were examined and a generous projection of business as usual rates was included. It was found that under all fitment scenarios the Option 6 benefit-cost ratios and net benefits were positive, highly significant in value, and well beyond those of the other options.

Crash likelihood with vehicle age

The likelihood of an Australian motorcycle of a particular age being involved in a crash was determined from the frequency of motorcycle crashes for motorcycles of that particular age in relation to the size of the motorcycle fleet for the year that motorcycle was supplied (registered). Figure 7 shows the history of new motorcycle registrations. It can be seen that new motorcycle registrations were increasing rapidly until the global financial crisis (GFC).

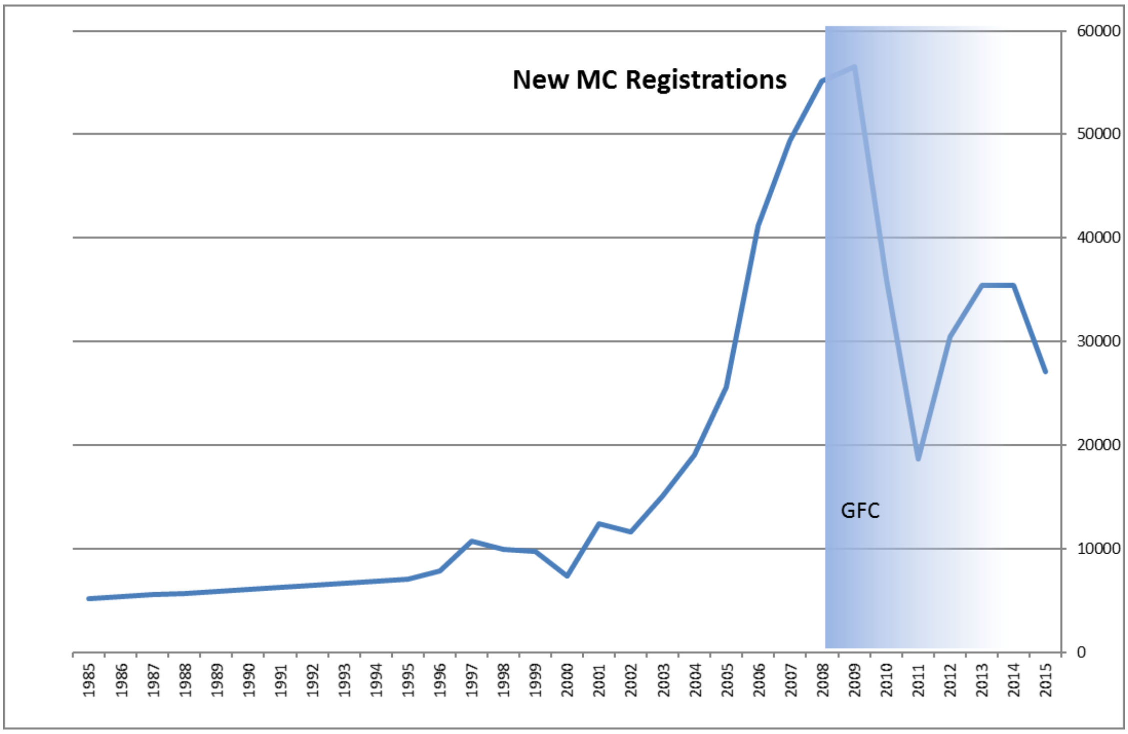

Figure 7: New Australian motorcycle registrations [data source - ABS, Motor Vehicle Census, cat. no. 9309.0, 1985–2015]

Figure 8 shows the crash frequency of motorcycles by age. The data is determined by sampling 2012 casualty crash data for the State of Victoria.

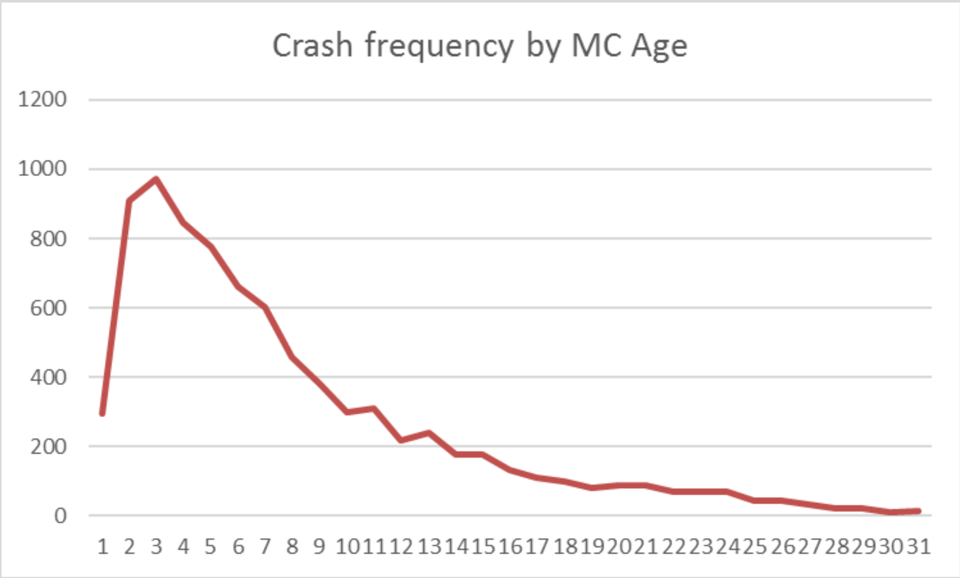

Figure 8: Crash frequency by motorcycle age (Victoria).

The resulting likelihood of a motorcycle of a given age being involved in a casualty crash over the course of a particular age-year is shown in Figure 9. It is clear from the trends that motorcycles that are going to be involved in a casualty crash are most likely to do so around 4 years of age. The equivalent series for Australian light passenger vehicles is provided for comparison.

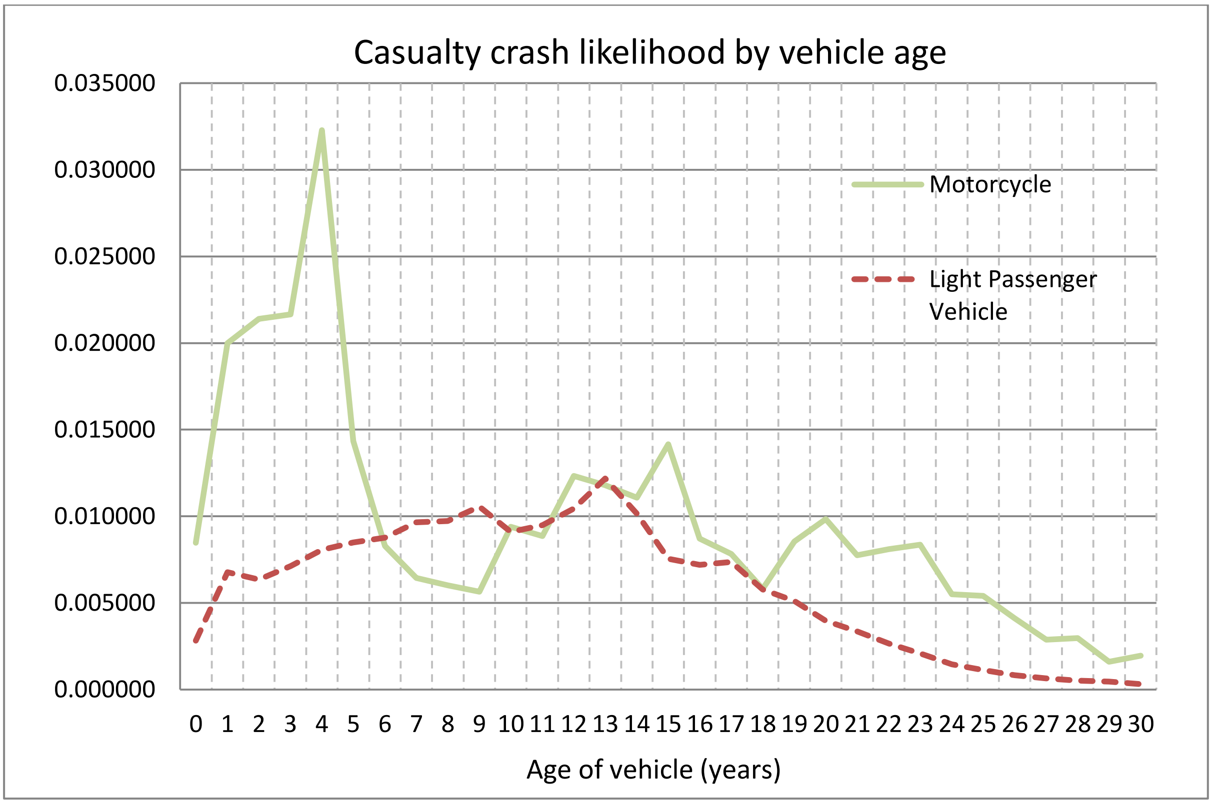

Figure 9: Australian motorcycle and light passenger vehicle casualty crash likelihoods by vehicle age

Life years lost per fatal motorcycle crash

Blackman reported in 2012 [63] that the median rider age for Australian motorcycle crashes is 35 years (scooter only: 39 years, moped only: 32 years).

Consistent with this figure, a 2016 publication Trends in serious injury due to road vehicle traffic crashes, Australia 2001 to 2010 [64] showed that the highest rates of motorcycle crashes exhibiting threat to life occurred in the male aged 25-44 demographic followed closely by males aged 15-24 (however, hospitalisation rates were also similarly high for the male aged 45-64 demographic). Demographic rates remained consistent throughout the 10-year study period.

In early 2017, BITRE provided data covering the period 2012-2016 that found the average age of a fatally injured motorcyclist was 40 years. Incorporating Australian Bureau of Statistics average male life expectancy of 80 years (96 per cent of rider fatalities are male), Australian motorcycle rider fatalities average a loss of 40 years of life.

4.2.2 Benefits

For a given technology effectiveness, benefits are produced by increasing fleet fitment. Over time, a technology penetrates the fleet as new (fitted) vehicles are purchased and old (not fitted) vehicles are scrapped.

For Option 1, there were no allocated benefits (or costs) as this was the BAU case. The forecast BAU fitment rate was used as a baseline, with the remaining options then evaluated against this.

The MUARC projection was replicated up to 2025. Starting with 40 per cent fitment in 2016, which closely matches the FCAI comparative figure of 43 per cent, an aggressive (conservative in terms of realised benefits under the other options) initial fitment rate was assumed. This was raised to over 90 per cent by 2025, followed by a more gradual increase to a maximum of approximately 95 per cent (Figure 10).

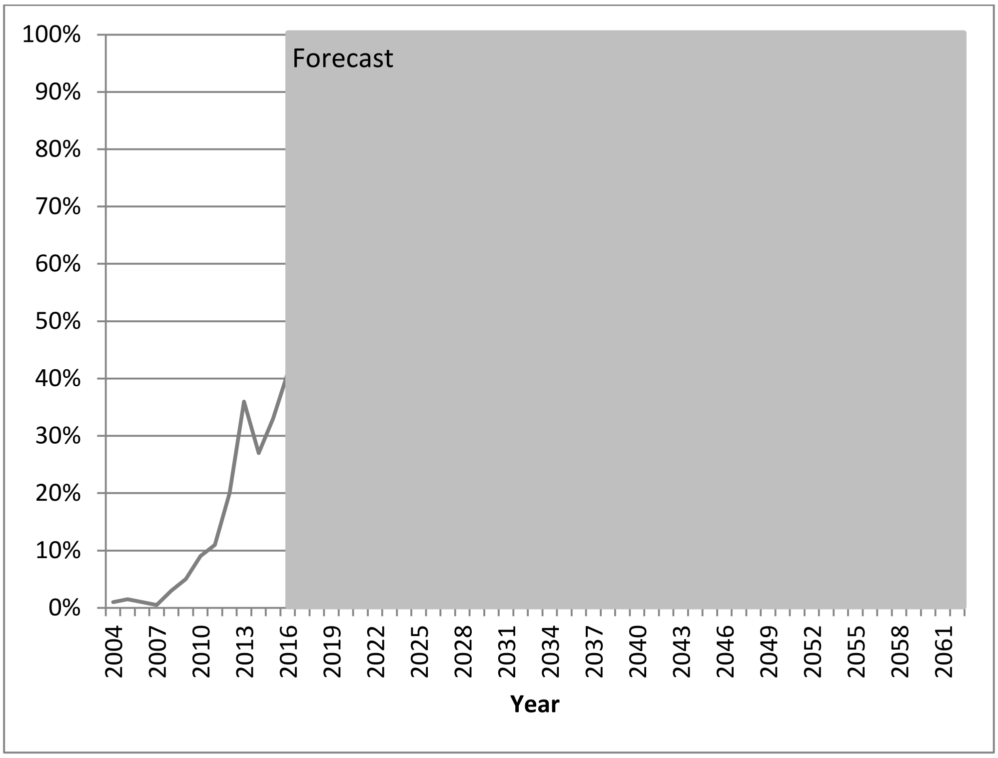

Figure 10: New motorcycle fitment of advanced braking systems, Option 1 (BAU)

For Options 2a, 2b, 6a and 6b, the benefits were established based on the difference between the BAU and the level of fitment under each proposed option.

Targeted awareness campaigns (Option 2a) have been estimated to increase technology fitment to up to 77 per cent. Once achieved via campaigning, a 77 per cent fitment for ABS technology would nonetheless eventually be overtaken by the BAU rate. The Option 2a fitment profile therefore tends towards the future (higher than 77 per cent) BAU rate after the initial campaign increases. After 6 years, campaigning becomes ineffective at increasing fitment over BAU due to the high BAU rates of fitment. The impact on fitment rate of Option 2a (targeted awareness) is shown in Figure 11: New motorcycle fitment of advanced braking systems, Option 2a (Advertising - targeted awareness).

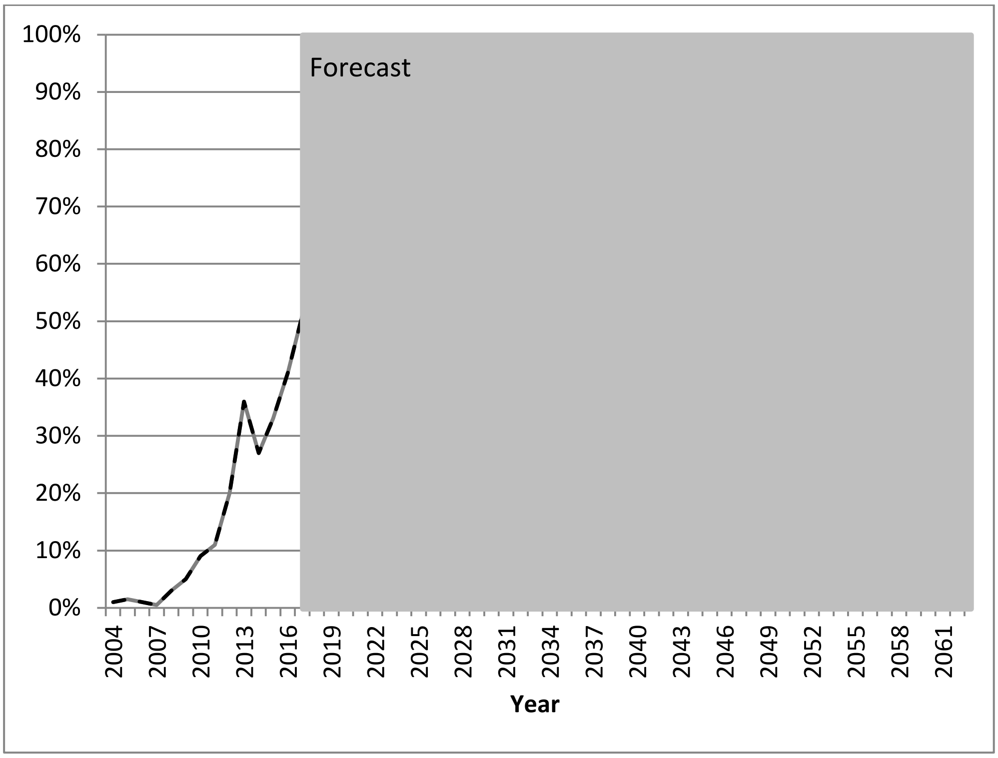

Figure 11: New motorcycle fitment of advanced braking systems, Option 2a (Advertising - targeted awareness)

Option 2b (advertising) adds 8 per cent fitment increase over BAU in the first year. Thereafter, advertising is considered less effective. The effect of advertising is therefore reduced in subsequent years over the policy lifespan at a conservative rate of 10 per cent (8 per cent in first year, 0.9*8 per cent in next year, etc). The assumed peak fitment attainable via advertising is 95 per cent (it is expected that some consumers will always prioritise cost and so choose motorcycles without ABS). As per Figure 12, Option 2a increases fitment over BAU for the full 15-year policy lifespan (though only marginally in later years).

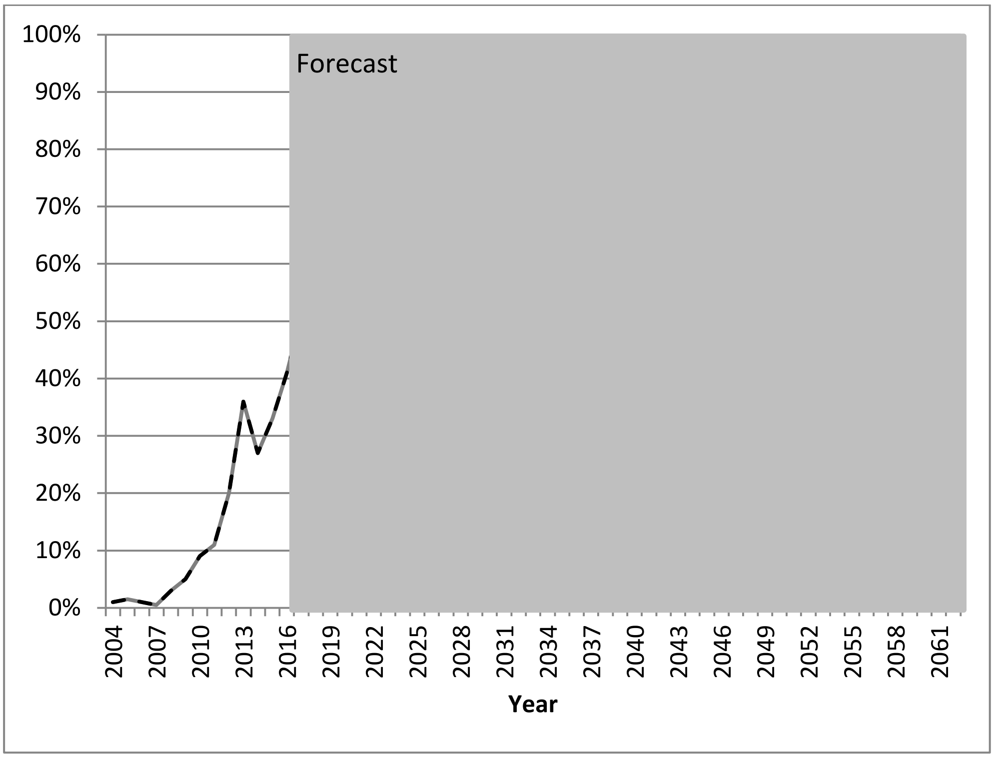

Figure 12: New motorcycle fitment of advanced braking systems, Option 2b (Advertising – information campaign)

Options that involve mandates (Option 6a and 6b) will lead to 100 per cent fitment of ABS/CBS technology on new motorcycles. This rate will be maintained throughout the mandate lifespan until, after 15 years, it may reduce over successive years to the forecast

BAU rate. To be conservative, a generous rate of decline in fitment rate was allowed immediately after the 15-year policy lifespan. In comparison to other options, mandated intervention would establish the most significant fitment increase over BAU for the policy lifespan and beyond. Figure 13 shows forecast fitment associated with a mandate.

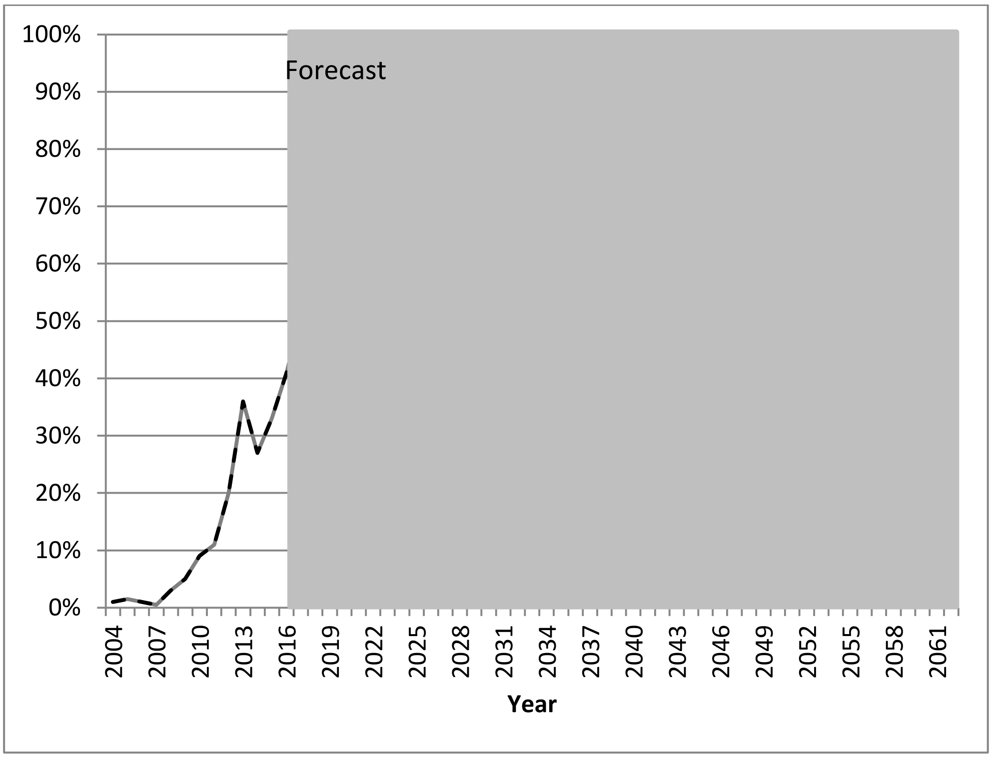

Figure 13: New motorcycle fitment of advanced braking systems, Option 6a and 6b (mandates)

4.2.3 Costs

Trauma costs

The total monetary cost to society of a statistical life lost per single fatality motorcycle crash (average loss of 40 life years) in 2017 Australian dollars is $4,750,837 [21]. The statistical cost per typical motorcycle crash resulting in serious hospitalised injury is $352,779 and the statistical cost per typical motorcycle event resulting in minor injury is $19,492 [22].

System development costs

Internationally recognised performance requirements for advanced motorcycle braking systems are defined in GTR No. 3 and UN Regulation No. 78. The adoption of international vehicle standards significantly reduces the development costs for manufacturers. This is because the bulk of the costs required to design and produce a motorcycle to meet these standards has already been invested in supplying to other regulated markets. There are no domestically produced motorcycles in Australia. Global manufacturers are already producing motorcycles with advanced braking systems for use in other markets as well as Australia, and have been conducting development and testing activities as part of this process.

The global development cost to a manufacturer of adding ABS to a previously non-fitted model is estimated through industry sources to cost between $100,000 to $200,000 per model (source parts from component suppliers, adapt motorcycle design to mount and support ABS braking components in place of standard braking components, and production line variations). The estimated development cost to add CBS to a previously non-fitted model is between $75,000 to $150,000 per model.

Standard braking system development for a new model also incorporates logistic, design, and fitment costs. This means that the estimated development costs imposed by intervention are conservative because the cost to develop an advanced braking system has not been reduced by the amount saved by not developing the standard braking system.

As ABS/CBS has been mandated in several major motorcycle markets globally, it could be argued that a fraction of that development cost should be attributed towards the analysis of any Australian mandate. The proportion of new motorcycles sold in the Australian market is 0.3 per cent of the global market (Table 7). If a motorcycle is developed for sale in all markets, 0.3 per cent of the development cost would then be attributable to Australia. The majority of road registerable motorcycles sold in Australia are also available in Europe in a similar form.

[21] 'Willingness to pay' method [67]
[22] BITRE Report 102, Table 7.1 [68]

Table 7: System development costs attributable to Australian sales

Market	Sales	Year
Global motorcycle	**33,000,000**	**2013**
Australian motorcycle	108,711	2015
	100,000	2013 (est.)
Per cent Australian sales	**0.3%**	2013 (est.)

However, a small number of motorcycles marketed in Australia are not supplied to other markets that already require ABS/CBS. Noting that FCAI members represent the overwhelming majority of all Australian road motorcycle sales and that members' models are generally offered in Europe (with ABS/CBS), it is estimated that only 5 per cent of motorcycle models supplied uniquely to Australia would require additional ABS/CBS system development.

Development costs attributable to global models plus those attributable to unique Australian models become:

$0.003*0.95 + 1.0*0.05 = 0.053$ i.e., around 5.3 per cent of development costs are attributable to the Australian market.

It should be noted that in reality the estimation of 5 per cent unique Australian models requiring ABS/CBS development is not a critical parameter affecting the benefit-cost analysis. This was confirmed in the sensitivity analysis (setting this to 8 per cent imposes a maximum $1,043,000 development cost for Option 6b in the first year; setting it to 2 per cent imposes a maximum $289,000 development cost in the first year - both amounts are not significant in terms of the overall costs which are in the $40 to $100 million range).

The attributable development costs are most significant at the time of initial policy implementation but will reduce over time as mandated fitment approaches forecast business as usual fitment. This was modelled by reducing these costs linearly to zero over the 15-year policy life. This is being conservative as costs normally reduce rapidly – manufacturer costs being minimal in subsequent years once a vehicle model is updated (with all models expected to be updated in the first 3 years, following a typical 3 year product update cycle for these types of vehicles). It is furthermore conservative because FCAI has advised that a significant and increasing proportion of new motorcycles are already fitted with advanced braking systems (around 80 per cent) and these system development costs are not attributable to intervention, whereas the analysis conservatively presumes all new models incur development cost.

According to the Department's RVCS data, there were 45 new (road) motorcycle models certified for supply to market in 2015. This figure has been used to determine system development costs attributable to intervention. For example, for Option 6a the lower bound on ABS development costs attributable to Australia per model over capacity 125 cc (with approx.. 5 per cent unique Australian models) in the first year of intervention may be estimated as:

$100,000 * 45 models affected in first year * 5.3% Australian attrib. = $237,955.

Lower and upper estimated bounds on the annual system development costs to industry induced by intervention under Option 6a for the 15 year policy period (after which development costs imposed by intervention will have reached zero) are shown in Table 8.

Table 8: System development costs, Option 6a

Year	System development costs (min)	System development costs (max)
2018	237,955	475,909
2019	222,091	444,182
2020	206,227	412,455
2021	190,364	380,727
2022	174,500	349,000
2023	158,636	317,273
2024	142,773	285,545
2025	126,909	253,818
2026	111,045	222,091
2027	95,182	190,364
2028	79,318	158,636
2029	63,455	126,909
2030	47,591	95,182
2031	31,727	63,455
2032	15,864	31,727

For Option 6b, lower and upper estimated bounds on the total annual system development costs (including ABS plus CBS development costs) to industry are shown in Table 9.

Table 9: System development costs, Option 6b

Year	System development costs (min)	System development costs (max)
2018	333,136	666,273
2019	310,927	621,855
2020	288,718	577,436
2021	266,509	533,018
2022	244,300	488,600
2023	222,091	444,182
2024	199,882	399,764
2025	177,673	355,345
2026	155,464	310,927
2027	133,255	266,509
2028	111,045	222,091
2029	88,836	177,673
2030	66,627	133,255
2031	44,418	88,836
2032	22,209	44,418

Costs to fit the systems

In their in their benefit-cost analysis, the European parliament adopted an ABS fitment cost of EUR 500 per motorcycle. This figure was based upon the 2009 manufacturer consultation report by Robinson et al. [40]. At that time, industry stakeholders reported that ABS fitment ranged in cost from EUR 150-822. Stakeholders also reported that CBS fitment ranged in cost between EUR 75-400 (noting that the cost to fit CBS is half that of ABS).

The EUR 500 figure was questioned by others, arguing that a suppliers' figure (based on what the cost to manufacturers would actually be by suppliers) of 150 EUR was more realistic. MUARC, for example, estimated that the actual cost to manufacturers to fit ABS to motorcycles of capacity greater than 125cc was EUR150 (approx. AU $220).

As a result of increased global supply of advanced braking systems for motorcycles in response to EU and other major markets' mandates, production and fitment costs are stabilising.

Accounting for the above considerations, an initial ABS fitment cost range of EUR 100 to 200 (AU$ 150 to 300) was used. Incorporating supplier and retail mark-up, the typical packaged price of motorcycle ABS seen by Australian consumers was then estimated to be in the range AU$ 300 to 600.

In line with research estimates, the cost of fitting CBS was taken to be half that of ABS: AU$ 150 to 300 per motorcycle fitted, which was then increased due to smaller economies of scale for the reduced number of CBS eligible motorcycles. This took the estimated typical cost range for motorcycle CBS fitment to AU$ 200 to 400.

These advanced braking system fitment costs were considered to be conservative, because they had not then been reduced by the amount saved in not having to fit a standard braking system. To be further conservative, the retail cost was used in lieu of a wholesale fitment cost in the analysis. Estimated fitment cost ranges used in the benefit-cost analysis are summarised in Table 10. As the typical system fitment costs may vary, the sensitivity analysis (Section 4.3) considered the effect of varying the tabled cost ranges.

Table 10: Estimated fitment cost ranges, per motorcycle

	Lower (AU$)	Upper (AU$)
ABS	300	600
CBS	200	400

Other business costs

Beyond the development and fitment cost of an ABS/CBS system, the cost of compliance to braking regulations under the current ADR 33/00 would not be materially changed by the addition of requirements for ABS/CBS. Therefore, this was not considered further.

Government costs

As discussed in Section 3.2.2, the estimated cost of a user information campaign that provides targeted consumer awareness which leads to 77 per cent fitment (Option 2a) was $3 million per year. The estimated cost for an advertising campaign that leads to an 8 per cent fitment increase over business as usual (Option 2b) is $9 million per year.

An estimated annual cost to government of $50,000 would be required to create, implement and maintain a mandatory regulation (Options 6a and 6b). This estimate includes the initial regulation development costs, as well as ongoing regulation maintenance and interpretation advice.

The cost to government to examine compliance to braking regulations remains the same, whether or not the braking system has ABS/CBS. Therefore, compliance costs to Government were not considered further.

Summary of costs

Table 11 provides a summary of costs associated with the implementation of viable Options 2a, 2b, 6a and 6b.

Table 11: Summary of costs associated with the implementation of each viable option

Costs related to:	Cost	Option(s)	Note	Cost Impact
System development (attributable to Australian market)	$238,000 to $476,000	6a	Per year. diminishing after first year	Business
	$333,000 to $666,000	6b		
Fitment of system				
ABS	$300 to $600	6a	Per vehicle	Business
CBS	$200 to $400	6a,b		
Campaign				
Targeted awareness	$3,000,000	2a	Per year	Government
Advertising	$9,000,000	2b		
Implement and maintain regulation	$50,000	6a,b	Per year	Government
Regulation compliance	$0	6a,b	Per model	Business

4.2.4 Benefit-Cost Analysis Results

Appendix 3—Benefit-Cost Analysis—Details of Results shows the calculations for the benefit-cost analysis. A summary of the results is provided below in Table 12. A seven per cent discount rate was used for all options.

Table 12: Summary of benefits, costs, lives saved and trauma avoided under Options 2a, 2b, 6a and 6b

	Net Benefits ($m)	Cost to Business ($m)	Cost to Government ($m)	Benefit Cost Ratio	Number of Lives Saved	Number of serious injuries avoided	Number of minor injuries avoided
Option 2a							
Best case	$372	$7	$14	18.2			
Likely case	**$368**	**$11**	**$14**	**15.6**	**97**	**1186**	**1353**
Worst case	$364	$15	$14	13.6			
Option 2b							
Best case	$379	$7	$82	5.3			
Likely case	**$375**	**$11**	**$82**	**5.1**	**190**	**2337**	**2666**
Worst case	$372	$14	$82	4.9			
Option 6a							
Best case	$1,465	$27	$0.5	55.3			
Likely case	**$1,452**	**$40**	**$0.5**	**37.1**	**534**	**7754**	**7484**
Worst case	$1,439	$53	$0.5	27.9			
Option 6b							
Best case	$1,633	$29	$0.5	55.6			
Likely case	**$1,618**	**$44**	**$0.5**	**37.2**	**587**	**8521**	**8225**
Worst case	$1,603	$59	$0.5	28.0			

4.3 Economic Aspects—Impact Analysis

An impact analysis examined the impact of each option on the affected parties. In doing so it considered the magnitude and distribution of the calculated benefits and costs.

4.3.1 Identification of Affected Parties

The affected parties were:

Business/consumers

- vehicle manufacturers or importers;
- vehicle owners;
- vehicle operators.

Governments

- Australian/state and territory governments and their represented communities.

The business/consumer parties are represented by several interest groups. Those relevant to the topic of this RIS include the:

- FCAI, that represents the automotive sector and includes motorcycle manufacturers, importers and component manufacturers/importers;
- Non-FCAI motorcycle manufacturers and importers.
- Australian Automobile Association (AAA) that represents motorcycle owners and riders through the various automobile clubs around Australia (RACQ, RACV, NRMA, RAA, etc.).
- Motorcycle advocacy groups such as Motorcycle Council of NSW, Victorian Motorcycle Council, Motorcycle Riders Association (Australia/Victoria, ACT, South Australia, Queensland, Western Australia), Rider Awareness Northern Territory, etc.
- Trainer/educator organisations such as Q-Ride, Stay Upright.

4.3.2 Impact of each Option

The impact of each option was examined in terms of quantifying the expected benefits and costs, then identifying how these would be distributed within the community. Five options/sub-options were considered: Option 1: no intervention; Option 2a: targeted awareness; Option 2b: advertising; and Option 6a and 6b: regulation. These are discussed below and summarised in Table 12.

Option 1: no intervention

In this option the government does not intervene, with market forces instead providing a solution to the problem.

As this option is the business as usual case, there are no benefits or costs allocated. The remaining option(s) are analysed relative to this option.

Option 2a and 2b - campaigns

Campaigns don't directly add significant development costs because consumers are educated to choose from existing (developed) models that already have the technology. Manufacturers profit on those motorcycles sold that suffice consumer interest/choice.

As per Section 3.2.2, targeted awareness campaigns inducing a year one 8 per cent increase in uptake cost $3 million per year. Due to increases in business as usual fitment of advanced braking systems for motorcycles, after 6 years a campaign is unlikely to be effective. Consumers choosing to purchase motorcycles fitted with the technology (that may otherwise not have been bought with an advanced braking systems) would cost industry approximately $11.0 million following a 6 year intervention campaign.

Similarly, advertising campaigns that increase uptake by up to 77 per cent would cost $9 million per year. The additional cost of fitment from consumer demand for motorcycles fitted with the technology would cost industry $10.5 million following a 15 year campaign.

Option 6a and 6b - mandatory standards for ABS/CBS

As these two sub-options involve direct intervention to compel a change in the safety performance of vehicles supplied to the marketplace, the benefits and costs are those that would occur over and above those of Option 1. The fitment of ABS/CBS would no longer be a commercial decision within this changed environment.

Benefits

Business

There would be no direct benefit to business as a result of a reduction in road trauma caused by motorcycles that are sold fitted with ABS/CBS due to the Australian Government mandating standards.

There would be an indirect benefit to business as a result of a reduction in the number of days work lost due to employees being injured in motorcycle crashes as well as a reduction in recruitment, training and personal development costs associated with the replacement of employees killed or permanently incapacitated due to motorcycle crashes.

Consumers

There would be a direct benefit to motorcycle owners and the wider community as a result of a reduction in road trauma for those who ride a motorcycle with ABS/CBS, due to the Australian Government mandating standards. Deaths and injuries due to crashes would be reduced, lessening the impact on the personal lives of road users as well as on insurance and other related systems. This benefit was able to be quantified in terms of lives saved and injuries reduced. For Option 6a there would be a saving of an estimated 534 lives, 7,754 severe injuries and 7,484 minor injuries as an outcome of the 15 year life of regulation. For Option 6b there would be an estimated saving of 587 lives, 8,522 severe injuries and 8,225 minor injuries. The BCRs determined were 37.07 for Option 6a and 37.22 for Option 6b.

Governments

There would be an indirect benefit to governments as a result of a reduction in road trauma to motorcyclists, due to the Australian Government mandating standards, in terms of the public health system and the general well-being of the community. This benefit was able to be quantified in terms of costs reduced. For Option 6b that exhibited the best bet benefit outcome, there would be a saving of $1.6 billion resulting from an assumed 15 year life of regulation. These benefits would be shared with governments and so the community. They represent a monetised saving of the lives and injuries reported above.

<u>Costs</u>

Business/consumers

There would be a direct cost to business/consumers as a result of additional design, fitment and testing costs for motorcycles that are sold fitted with ABS/CBS, due to the Australian Government mandating standards. This cost would likely be passed onto the consumer by business.

Governments

There would be a cost to governments for developing, implementing and administering regulations (standards) that require motorcycles to meet the proposed minimum level of safety performance. This cost was able to be quantified and would cost $0.5 million over an assumed 15 year life of regulation.

Table 13: Summary of Results –Options 2a,2b,6a and 6b, 35-year run-out period

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Lives Saved	Major avoided	Minor avoided	Total Benefits	Total Costs
Option 2a: User information campaigns - targeted awareness (77% fitment effect, $3m campaign cost per year)									
Best Case	$371,705,566	$7,312,887	$14,299,619	18.20					
Likely Case	**$368,049,122**	**$10,969,330**	**$14,299,619**	**15.57**	**97**	**1,186**	**1,353**	**$393,318,071**	**$25,268,949**
Worst Case	$364,392,679	$14,625,773	$14,299,619	13.60					
Option 2b: User information campaigns - advertising (8% fitment increase on BAU, $9m campaign cost per year)									
Best Case	$378,671,629	$7,001,984	$81,971,226	5.26					
Likely Case	**$375,170,637**	**$10,502,976**	**$81,971,226**	**5.06**	**190**	**2,337**	**2,666**	**$467,644,838**	**$92,474,202**
Worst Case	$371,669,645	$14,003,968	$81,971,226	4.87					
Option 6a: Mandatory standards ABS>=125 (100% fitment effect)									
Best Case	$1,465,101,952	$26,528,438	$455,396	55.30					
Likely Case	**$1,451,837,733**	**$39,792,657**	**$455,396**	**37.07**	**534**	**7,753**	**7,484**	**$1,492,085,786**	**$40,248,053**
Worst Case	$1,438,573,514	$53,056,876	$455,396	27.88					
Option 6b: Mandatory standards ABS>=125 & 50<=CBS/ABS<125 (100% fitment effect)									
Best Case	$1,633,038,339	$29,479,937	$455,396	55.55					
Likely Case	**$1,618,298,370**	**$44,219,905**	**$455,396**	**37.22**	**587**	**8,521**	**8,225**	**$1,662,973,671**	**$44,675,301**
Worst Case	$1,603,558,402	$58,959,873	$455,396	27.99					

5 WHO HAS BEEN CONSULTED?

5.1 Consultative Committees

The Department undertakes public consultation on significant proposals. Depending on the nature of the proposed changes, consultation may involve community and industry stakeholders as well as established government committees such as the Technical Liaison Group (TLG), Strategic Vehicle Safety and Environment Group (SVSEG), Transport and Infrastructure Senior Officials' Committee (TISOC) and the Transport and Infrastructure Council (TIC).

- TLG consists of technical representatives of government (Australian and state/territory), the manufacturing and operational arms of the industry (including organisations such as the Federal Chamber of Automotive Industries and the Australian Trucking Association) and of representative organisations of consumers and road users (particularly through the Australian Automobile Association).
- SVSEG consists of senior representatives of government (Australian and state/territory), the manufacturing and operational arms of the industry and of representative organisations of consumers and road users (at a higher level within each organisation as represented in TLG).
- TISOC consists of state and territory transport and/or infrastructure Chief Executive Officers (CEOs) (or equivalents), the CEO of the National Transport Commission, New Zealand and the Australian Local Government Association.
- TIC consists of the Australian, state/territory and New Zealand Ministers with responsibility for transport and infrastructure issues.

While the TLG sits under the higher level SVSEG forum, it is still the principal consultative forum for advising on the more detailed aspects of ADR proposals. Membership of the TLG is shown at Appendix 5 —Technical Liaison Group (TLG).

Development of safety related ADRs under the MVSA is the responsibility of the Vehicle Safety Standards Branch of the Department of Infrastructure and Regional Development. It is carried out in consultation with representatives of the Australian Government, state and territory governments, manufacturing and operating industries, road user groups and experts in the field of road safety. Under Part 2, section 8 of the MVSA the Minister may consult with state and territory agencies responsible for road safety, organisations and persons involved in the road vehicle industry and organisations representing road vehicle users before determining an ADR.

The option to mandate advanced braking systems for motorcyclist safety (Option 6) has been discussed at a number of SVSEG and TLG meetings. It has also been discussed at dedicated preliminary consultation rounds hosted by state and territory authorities (Section 2.2.2). Any issues raised within these consultative groups have been considered within the Early Assessment RIS, alongside proposed solutions. Although the general approach to Option 6 within the RIS received broad support within the consultative groups, it was anticipated that additional feedback would be provided during the public comment period.

5.2 Public Comment – Early Assessment RIS

Issuing an Early Assessment RIS for public comment is an integral part of the ADR consultation process. It provides an opportunity for businesses, government agencies, road user groups and other interested parties to provide input to ADR proposals. Analysing proposals through the RIS process assists in identifying likely impacts and enables informed debate on any issues.

In line with the Australian Government Guide to Regulation (2014), in May 2017 an Early Assessment RIS was circulated publicly for a six-week comment period. There were 11 non-confidential and 3 confidential responses received including from state and territory governments, industry and motorcycling groups. Overall, the responses demonstrated broad support for establishing an ADR for advanced motorcycle braking systems, in line with EU requirements. The confidential responses included one statement of support and 2 detailed requests around the scope of exemptions.

There was strong support for aligning the requirements with the latest international changes (as adopted by the EU) for a rider being able to temporarily switch ABS off, to allow for the safe off-road operation of adventure tourer motorcycles designed for dual purpose use (on-road and off-road). There was also support for providing an additional exemption for some Australian specific motorcycles (small capacity trail motorcycles) designed primarily for off-road use (refer Section 3.2.6 - it should be noted that the /04 series of UN Regulation No. 78 has recently been adopted internationally and is now in force).

In consultation with industry and government experts, both of these technical adaptations were accommodated into a proposed ADR (Section 5.3, below).

Other issues raised during the public consultation process (and Departmental responses) are reported in Appendix 8 – *Public Comment, Early Assessment Regulation Impact Statement*.

5.3 Exposure Draft – ADR 33/01

Following the six-week consultation period for the Early Assessment RIS and analysis of the feedback received, an exposure draft for a new ADR 33/01was compiled and circulated for two and a half weeks amongst key state and territory agencies and industry stakeholders. The contents of the draft reflected the structure as described in Section 3.2.6 as well as the responses to the Early Assessment RIS noted above. There were no issues raised with the draft during this second consultation period.

6 WHAT IS THE BEST OPTION?

This RIS identified opportunities to improve motorcycle safety in Australia via advanced braking systems. After consultations with industry, governments and consumers, a total of six options, including both regulatory and non-regulatory options were considered:

- Option 1: no intervention (business as usual);
- Option 2: campaigns, a - targeted awareness, b - advertising;
- Option 3: fleet purchasing policies;
- Option 4: codes of practice;
- Option 5: mandatory standards under the *Competition and Consumer Act 2010* (C'th); and
- Option 6: mandatory standards under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) (regulation), a - ABS for motorcycle capacity 50cc and above, b - ABS for motorcycle capacity over 125cc and Combined Braking Systems (CBS) or ABS for motorcycle capacity 50cc to 125cc.

Of these options, the viable options 1, 2a, 2b, 6a and 6b were examined in detail. The results of a benefit-costs analysis examining outcomes over a 35-year period for each of these options (from a policy intervention period of 15 years) are summarised in Table 1 to Table 3.

Table 14: Summary of net benefits and gross benefits for each option

	Net benefits ($m)			**Total benefits before costs ($m)**
	Best case	Likely case	Worst case	
Option 1: no intervention	-	-	-	-
Option 2a: targeted awareness	372	**368**	364	393
Option 2b: advertising	379	**375**	371	468
Option 6a: mandatory ABS	1465	**1452**	1439	1492
Option 6b: mandatory ABS/CBS	1633	**1618**	1604	1663

Table 15: Summary of costs and benefit-cost ratios for each option

	Costs ($m)			**Benefit-cost ratios**		
	Best case	Likely case	Worst case	Best case	Likely case	Worst case
Option 1: no intervention	-	-	-	-	-	-
Option 2a: targeted awareness	22	**25**	29	18.2	**15.6**	13.6
Option 2b: advertising	89	**92**	96	5.3	**5.1**	4.9
Option 6a: mandatory ABS	27	**40**	54	55.3	**37.1**	27.9
Option 6b: mandatory ABS/CBS	30	**45**	59	55.6	**37.2**	28.0

Table 16: Summary of number of lives saved and severe and minor injuries avoided

	Lives saved	Severe injury	Minor injury
Option 1: no intervention	-	-	-
Option 2a: targeted awareness	97	1186	1353
Option 2b: advertising	190	2337	2666
Option 6a: mandatory ABS	534	7754	7484
Option 6b: mandatory ABS/CBS	587	8522	8225

Option 6b: mandatory ABS/CBS generated the highest net benefits of the options examined ($1.62 billion) as well as the highest number of lives saved (587) over a 35 year run-out period following a 15-year intervention with mandatory standards. This option also yields the highest likely benefit cost ratio of 37.2. It represents significant road trauma savings, especially when compared to other recent vehicle safety initiatives.

According to the Australian Government Guide to Regulation (2014) ten principles for Australian Government policy makers, the policy option offering the greatest net benefit should be the recommended option. It is important to also highlight that early adoption of international best-practice standards (as has been done with motorcycle ABS mandates in other countries) would safeguard Australia from becoming the recipient of lesser-equipped motorcycles not permitted for sale in other economies. In this case harmonisation with international vehicle standards is particularly important because the overwhelming majority of motorcycles sold in Australia are imported.

For these reasons *Option 6b - mandatory standards: ABS for motorcycle capacity over 125cc; and, CBS or ABS for motorcycle capacity 50cc to 125cc* is the recommended option.

Option 6b offers the further advantage of being able to guarantee 100 per cent provision of ABS/CBS to applicable vehicles. There would be no guarantee that non-regulatory options, such as Option 3, would deliver an enduring result, nor that the predicted take-up of advanced braking systems would be reached and then maintained. Changing economic pressures, or the entry of new players into the market, could see a shift away from the current move to provide enhanced side impact protection measures for motorcycles, particularly at the lower, more competitive end of the market

It should be recognised that measures such as those described for Options 2, 3 and 4, e.g. advertising campaigns have already contributed to the current level of take-up of advanced braking systems for motorcycles. These could continue in one form or another regardless of the recommendations of this RIS.

6.1 Discussion of the Recommended Option

In terms of efficiency of regulation, the BCR for Option 6b is 37. This is high for a vehicle safety proposal, typically it is around 2.0. There are a number of reasons why the potential for savings in road trauma through the introduction of advanced braking systems is so large.

i. Firstly, while motorcycles represent only 1 per cent of registered Australian vehicle kilometres travelled, motorcyclists represent 18 per cent of road user fatalities and 28 per cent of hospitalisation trauma. Therefore, any improvement in motorcycle safety affects a large part of Australia's road toll.

ii. Secondly, of those killed in motorcycle crashes, a high proportion are young, so on average there is significant loss of "life years".

iii. Thirdly, advanced braking systems have been shown to be very effective at reducing motorcyclist trauma in the vast majority of crash types, particularly for fatal and serious trauma crashes, which are relatively frequent and very costly. It has been possible to demonstrate this high level of effectiveness using real-world Australian data.

The reason why the mandatory standards options both have higher net benefits and BCRs than the non-mandatory options is because the cost of fitment and compliance to the relevant standards is less than the cost of ongoing campaigns needed to encourage the purchasing of motorcycles fitted with advanced braking systems.

As Australia receives less than 1 per cent of motorcycles destined for the global market and because models supplied are not unique to Australia (with many more imported models fitted with ABS/CBS due to mandates in other economies), the cost attributed to system development for motorcycles destined for supply to Australia can be significantly reduced. This then leads to exceptionally favourable BCRs in considering the case for mandating in Australia.

Combining the above factors it is not surprising to see the potential for much improved BCRs in Australia today than those reported in older overseas studies.

A sensitivity analysis examined the effects of wide variations to the key parameters. These included the discount rate; technology effectiveness; number of motorcycle models affected by the particular intervention each year; per cent of fleet eligible for CBS, the fitment rate and cost, and sales growth forecasts. The most impact on net benefit arose from the fitment cost and discount rate, with variation in other parameters resulting in little change. Notably, the net benefits from the options remained positive and significant, while the relative ranking of the options stayed the same.

For Option 6b, adding CBS requirements for scooters and small motorcycles helps to protect an expanded cohort of motorcyclists that includes many inexperienced riders. This results in the greatest net benefit and BCR of all options considered.

6.2 Timing of the Recommended Option

The majority of contracting parties to the 1958 Agreement including 28 EU member states, Japan, India, Taiwan and Brazil have announced mandates for the fitment of motorcycle ABS/CBS through UN Regulation No. 78. The US is not a signatory to UN regulations but is to GTRs and has adopted GTR No. 3 but has not at this stage set ABS/CBS as a mandatory requirement for motorcycles supplied into the US market.

In the case of the EC, the mandate was introduced in 2012 via regional legislation PE-CONS 52/12[23], with phased-in implementation from January 2016 for new models until all models must comply in 2017. In Brazil, from 2016 new motorcycles models must comply with new fitment requirements and by 2019 all models must comply. In India, new motorcycle models must comply with similar braking requirements for new models from April 2017 and existing models from April 2018. In Japan, new models must comply from October 2018, and all models must comply from October 2021. In Taiwan, new models must comply from January 2019, and all models must comply from January 2021.

As identified in the MUARC research report, and as independently analysed later in this RIS (Section 4), early intervention would yield significantly beneficial trauma and dollar cost outcomes over those of business-as-usual. Most notably, these benefits are significantly more substantial the earlier that intervention is pursued. The usual lead time for an ADR change that results in an increase in stringency is 18 months for new models and 24 months for all other models.

Timing for the recommended intervention has been selected in consultation with stakeholders. The proposed implementation schedule is:

- 1 November 2019 for all new model ADR category LC motorcycles.
- 1 November 2021 for all ADR category LC motorcycles.

While the usual lead time for an ADR change that results in an increase in stringency is 18 months for new models and 24 months for all other models, there is variation on this depending on circumstances. In this case, the implementation schedule is just over this typical lead time.

6.3 Scope and Requirements

The following mandated requirements are recommended:

- for motorcycles having engine capacity above 125 cubic centimetres (and equivalent), ABS must be fitted to modulate any wheel lock; and,
- for motorcycles having engine capacity above 50 cubic centimetres (or equivalent) and engine capacity 125 cubic centimetres or below (or equivalent), ABS must be fitted to modulate any wheel lock; or, CBS must be fitted;

[23] http://register.consilium.europa.eu/doc/srv?l=EN&f=PE%2052%202012%20INIT

where:

- engine capacity 125 cubic centimetres equivalent is defined as net power 11 kW and power/weight ratio 0.1 kW/kg; and,
- engine capacity 50 cubic centimetres equivalent is defined as continuous rated or net power 4 kW.

In consultation with stakeholders, the following provision for ABS deactivation is recommended for the safe off-road use of non-exempt dual purpose and adventure-tourer type motorcycles:

For LC category vehicles designed for use on loose or unsealed surfaces or unformed roads and that are fitted with tyres appropriate for use on those surfaces, a means to temporarily disable ABS for the purpose of off-road use is permitted where that means conforms to the requirements of UN Regulation No. 78 series /04.

6.4 Exemptions for Motorcycles Designed Primarily to be Ridden Off-road

In consultation with stakeholders, the following exemptions are recommended for motorcycles designed primarily to be ridden off-road.

To begin with, the existing exemptions for enduro and trials motorcycles under the EU are proposed to be adopted, providing the benefit of harmonised requirements to global manufacturers.

Therefore, it is recommended that ADR category LC vehicles designed for use on loose or unsealed surfaces or unformed roads and that are fitted with tyres appropriate for use on those surfaces are exempt as per EU exemptions for 'enduro' and 'trial' motorcycles:

European 'enduro' motorcycle exemption - L3e-AxE (x = 1, 2 or 3)

(a) seat height ≥ 900 mm and

(b) ground clearance ≥ 310 mm and

(c) overall gear ratio in highest gear (primary gear ratio × secondary gear ratio in the highest speed × final drive ratio) ≥ 6.0 and

(d) mass in running order plus the mass of the propulsion battery in case of electric or hybrid electric propulsion ≤ 140 kg and

(e) no seating position for a passenger.

European 'trial' motorcycle exemption - L3e-AxT (x = 1, 2 or 3)

(a) seat height ≤ 700 mm and

(b) ground clearance ≥ 280 mm and

(c) fuel tank capacity ≤ 4 litres and

(d) overall gear ratio in highest gear (primary gear ratio × secondary gear ratio in the highest speed × final drive ratio) ≥ 7.5 and

(e) mass in running order ≤ 100 kg and

(f) no seating position for a passenger.

Mass in running order determination is as per 1. and 2 below, European Union Law definition:

1. The mass in running order of an L-category vehicle shall be determined by measuring the mass of the unladen vehicle ready for normal use and shall include the mass of:

(a) liquids;

(b) standard equipment in accordance with the manufacturer's specifications;

(c) 'fuel' in the fuel tanks that shall be filled to at least 90 % of their capacities.

For the purposes of this point:

(i) if a vehicle is propelled with a 'liquid fuel' this shall be considered as 'fuel';

(ii) if a vehicle is propelled with a liquid 'fuel/oil mixture':

- if fuel to propel the vehicle and lubrication oil are pre-mixed then this 'pre-mixture' shall be considered as 'fuel',

- if fuel to propel the vehicle and lubrication oil are stored separately then only 'fuel' propelling the vehicle shall be considered as 'fuel'; or

(iii) if a vehicle is propelled by a gaseous fuel, a liquefied gaseous fuel or is running on compressed air, the mass of 'fuel' in the gaseous fuel tanks may be set to 0 kg;

(d) the bodywork, the cabin, the doors; and

(e) the glazing, the coupling, the spare wheels as well as the tools.

2. The mass in running order of an L-category vehicle shall exclude the mass of:

(a) the driver (75 kg) and passenger (65 kg);

(b) the machines or equipment installed on the load platform area;

(c) in the case of a hybrid or pure electric vehicle, the propulsion batteries;

(d) in the case of mono-fuel, bi-fuel or multi-fuel vehicles, a gaseous fuel system as well as storage tanks for gaseous fuel; and

(e) in the case of pre-compressed air propulsion, storage tanks to store compressed air.

In addition, stakeholders have supported an additional exemption for some Australian-specific motorcycles designed primarily to be ridden off-road. Accordingly, category LC vehicles designed for use on loose or unsealed surfaces or unformed roads and that are fitted with tyres appropriate for use on those surfaces are exempt where they conform to the following:

(a) seat height ≥ 810 mm and

(b) ground clearance ≥ 285 mm and

(c) overall gear ratio in highest gear (primary gear ratio × secondary gear ratio in the highest speed × final drive ratio) ≥ 6.0 and

(d) unladen mass ≤ 150 kg and

(e) no seating position for a passenger and no passenger foot rests and

(f) engine capacity ≤ 250 cc (or equivalent[24]) and

(g) front wheel outer rim diameter equal to or greater than 533 mm (nominally 21 inches) and larger than rear wheel outer rim diameter.

The above exemptions are defined to be applicable to off-road capable motorcycles, including uniquely Australian "trail" motorcycles where they are small in mass and capacity. Industry advises that although the additional Australian exemption would result in ABS/CBS exemptions reaching around 30 per cent of all new off-road designed motorcycles, this would still represent less than 4 per cent of total on-road and off-road Australian motorcycle sales.

6.5 Impacts

Governments or private organisations would absorb much of the cost of the intervention.

Business/consumers

The costs to business would be passed on to the consumers, as the vehicle industry is driven by margins.

The benefits would flow to the community (due to the existing negative externalities of road crashes) and those consumers or their families that are directly involved in crashes.

Governments

The Australian Government maintains and operates a vehicle certification system, which is used to ensure that vehicles first supplied to the market comply with the ADRs. A cost recovery model is used and so ultimately the cost of the certification system as a whole is recovered from business.

[24] Engine capacity 250 cubic centimetres equivalent is defined as net power 22 kW and power/weight ratio 0.15 kW/kg.

6.6 Offsets

The Australian Government Guide to Regulation (2014) requires that all new regulatory options are costed using the Regulatory Burden Measurement (RBM) Framework. Under the RBM Framework, the regulatory burden is the cost of a proposal to business and the community (not including the cost to government). It is calculated in a prescribed manner that usually results in it being different to the overall costs of a proposal in the benefit-cost analysis. In line with the RBM Framework, the average annual regulatory costs were calculated for this proposal by totalling the undiscounted (nominal) cost (including development and fitment cost) for each option over the first 10 years of intervention. This total was then divided by 10.

The RBM per year, calculated in accordance with the Government's RBM framework (Appendix 3, page 119) for each viable option is: Option 2a $1,271,221; Option 2b $1,171,909; Option 6a $4,463,941; Option 6b $4,968,240. Table 17 summarises the regulatory burden and cost offsets for recommended Option 6b.

Table 17: Regulatory burden and cost offset estimate table – Option 6b

Average annual regulatory costs (relative to business as usual)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$4.97m[1]	-	-	$4.97m
Are all new costs offset? ☑ Yes, costs are offset ☐ No, costs are not offset ☐ Deregulatory—no offsets required				
Total (Change in costs – Cost offset) ($ million) = $0				

1/ the costs to business are expected to be passed on to consumers.

The Australian Government Guide to Regulation sets out ten principles for Australian Government policy makers. One of these principles is that all new regulations (or changes to regulations) are required to be quantified under the RBM Framework and, where possible, offset by the relevant portfolio.

It is anticipated that regulatory savings from further alignment of the ADRs with international standards will offset the additional RBM costs of this measure.

7 IMPLEMENTATION AND EVALUATION

New ADRs or amendments to the ADRs are determined by the Assistant Minister for Infrastructure and Regional Development under section 7 of the MVSA. At the time that the amendment is signed by the Minister, registered subscribers to the ADRs are e-mailed directly notifying them of the new ADR or the amendment to the ADR. Registered subscribers to the ADRs include but are not limited to various industry groups such as vehicle manufacturers, designers and test facilities, and vehicle user organisations.

As Australian Government regulations, ADRs are subject to review every ten years as resources permit. This ensures that they remain relevant, cost effective and do not become a barrier to the importation of safer vehicles and vehicle components. The new ADR would be scheduled for a full review on an ongoing basis and in line with this practice.

CONCLUSION AND RECOMMENDATION

Motorcycles represent only 4 per cent of registered Australian vehicles and only 1 per cent of kilometres travelled. However, motorcyclists represent around 18 per cent of all road deaths and 22 per cent of all road related hospitalisations. Motorcycle trauma currently costs the Australian economy around $2 billion each year. The most frequent age group for motorcyclist hospitalisation is 25 years and under.

The most recent available traffic data shows annual growth in motorcyclist deaths at 22 per cent (2016). Motorcyclist trauma is increasing as the Australian motorcycle sector expands with the highest growth of vehicle sales in Australia. This growth results in an increase in the number of novice level riders (including new and returning riders).

These increases in motorcyclist trauma have occurred despite significant efforts to improve motorcyclist safety from industry, consumer groups, and state and territory jurisdictions. The initiatives take the form of road user information and awareness campaigns, rider education, training and skills development schemes, safety equipment and technology promotion, market incentives, and infrastructure treatments.

Of the available countermeasures to motorcyclist trauma, advanced braking technologies such as ABS and CBS are considered the most viable. A report commissioned by the Australian Government and Victorian Government found that advanced braking systems for motorcycles reduce motorcycle trauma crashes in Australia by 31 per cent overall, with a 36 per cent effectiveness in alleviating serious and fatal trauma crashes. These figures align with international findings.

In line with international initiatives, there have been a number of campaigns across Australia that both emphasise the benefits of advanced motorcycle braking systems and encourage choosing them when purchasing a motorcycle. Like in international markets, despite modest increases in fitment, targeted fitment rates have not been achieved. In such situations, regulation can step in to guarantee the safety and economic benefits of .improved fitment rates. As a result, fitment of advanced motorcycle braking systems has now been mandated (based upon UN regulations) in major markets such as all 28 member states of the European Union (EU), Japan, Taiwan, Brazil and India. With such mandates in effect in international markets, global suppliers are well-positioned to provide significant fitment increases in the Australian market.

Harmonising with UN requirements provides consumers with access to vehicles meeting the latest levels of safety and innovation, at the lowest possible cost. It is particularly important because the overwhelming majority of motorcycles sold in Australia are imported. Australia participates in the peak United Nations (UN) forum (known as WP.29) that sets both the framework and technical requirements for international vehicle standards. The adoption of international standards as a basis for regulation facilitates achieving the highest safety levels at the lowest possible cost to the consumer. Australia is a Contracting Party to the two main treaties for the development of international vehicle standards, the 1958 Agreement that develops UN regulations and the 1998 Agreement that develops Global Technical Regulations (GTRs).

In relation to motorcycle braking systems two UN standards exist, both containing substantively the same requirements - UN Regulation No.78 [Braking – category L vehicles] and GTR No. 3 [Motorcycle brakes]. The majority of contracting parties to the 1958 Agreement including 28 EU member states, Japan, India, Taiwan and Brazil have announced mandates for the fitment of advanced motorcycle braking systems through UN Regulation No. 78.

This Regulation Impact Statement examined the case for Australian Government intervention to enhance motorcyclist safety. A total of six options, including both regulatory and non-regulatory options were explored. Option 6b: *mandatory ABS/CBS* generated the highest net benefits of the options examined ($1.62 billion) as well as the highest number of lives saved (587) over a 35 year run-out period following a 15-year intervention with mandatory standards. This option is based on the requirements of UN Regulation No.78 and yields the highest likely benefit cost ratio of 37.2. It represents significant road trauma savings, especially when compared to other recent vehicle safety initiatives.

According to the Australian Government Guide to Regulation (2014) ten principles for Australian Government policy makers, the policy option offering the greatest net benefit should always be the recommended option. In this case it is Option 6b and this was also the option most strongly supported by stakeholders during the consultation process.

The adoption of Option 6b would safeguard Australia from becoming the recipient of lesser-equipped motorcycles, particularly those not permitted for sale in other economies that have already introduced a similar policy option. Harmonisation with international vehicle standards is particularly important because the overwhelming majority of motorcycles sold in Australia are imported.

For these reasons Option 6b - *mandatory standards: ABS for motorcycle capacity above 125cc; and, CBS or ABS for motorcycles with engine capacity above 50cc and engine capacity 125cc or below* is the recommended option.

Under Option 6b the following mandatory requirements, which are in line with EU requirements, would be prescribed in an ADR for new vehicles:

- for motorcycles having engine capacity above 125 cubic centimetres (and equivalent), ABS must be fitted to modulate any wheel lock; and,
- for motorcycles having engine capacity above 50 cubic centimetres (or equivalent) and engine capacity 125 cubic centimetres or below (or equivalent), ABS must be fitted to modulate any wheel lock; or, CBS must be fitted;

where:

- engine capacity 125 cubic centimetres equivalent is defined as net power 11 kW and power/weight ratio 0.1 kW/kg; and,
- engine capacity 50 cubic centimetres equivalent is defined as continuous rated or net power 4 kW.

Stakeholders have also supported allowing the following, which, under Option 6b, would be included in the ADR:

- a means to disable ABS for safe off-road operation of adventure tourer motorcycles designed for dual purpose use (on-road and off-road); and
- an additional exemption for some Australian specific motorcycles (small mass and capacity “trail” motorcycles) designed primarily to be ridden off-road.

Based on feedback during consultation as well as general consideration of the type of design, testing and production changes needed to implement Option 6b, the recommended implementation schedule is:

- 1 November 2019 for all new model ADR category LC motorcycles.
- 1 November 2021 for all ADR category LC motorcycles.

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APPENDIX 1—ACRONYMS AND ABBREVIATIONS

AAA	Australian Automobile Association
ABS	Anti-lock Braking Systems
ACCC	Australian Competition and Consumer Commission
ACEM	Association of European Motorcycle Constructors
ADR	Australian Design Rule
ANCAP	Australasian New Car Assessment Program
ATV	All-Terrain Vehicles
BAU	Business as Usual
BCR	Benefit-Cost Ratio
BITRE	Bureau of Infrastructure, Transport and Regional Economics
C&C Act	Competition and Consumer Act 2010
CARRS-Q	Centre for Accident Research & Road Safety Queensland
CASR	Centre for Automotive Safety Research
CEO	Chief Executive Officer
CBS	Combined Braking System
C-ITS	Connected Intelligent Transport System
CRASH	Consumer Rating and Assessment of Safety Helmets
EC	European Commission
EU	European Union
ESC	Electronic Stability Control
ETSC	European Transport Safety Council
FCAI	Federal Chamber of Automotive Industries
GLS	Graduated Licensing System
GTR	Global Technical Regulation
GVM	Gross Vehicle Mass
HLDI	Highway Loss Data Institute
IAM	Institute for Advanced Motorcyclists
IIHS	Insurance Institute for Highway Safety
IMMA	International Motorcycle Manufacturers Association
LAMS	Learner Approved Motorcycle Scheme
MUARC	Monash University Accident Research Centre
MVSA	*Motor Vehicle Standards Act 1989*
NCAP	New Car Assessment Program
NHTSA	National Highway Traffic Safety Administration
NPV	Net Present Value
NRMA	National Roads and Motorists' Association
NRSS	National Road Safety Strategy 2011-2020
OBPR	Office of Best Practice Regulation
RAA	Royal Automobile Association of South Australia
RACV	Royal Automobile Club of Victoria
RIS	Regulation Impact Statement
RTO	Registered Training Organisation

RVCS	Road Vehicle Certification System
SVSEG	Strategic Vehicle Safety and Environment Group
TAC	Transport Accident Commission of Victoria
TIC	Transport and Infrastructure Council
TISOC	Transport and Infrastructure Senior Officials' Committee
TLG	Technical Liaison Group
TRL	Transport Research Laboratory
UN	United Nations
US	United States
WP.29	World Forum for the Harmonization of Vehicle Regulations

APPENDIX 2—RELATED VEHICLE CATEGORIES

Two and three-wheeled vehicle categories as reproduced from Sections 4.2, 5.1 and 5.2 of *Vehicle Standard (Australian Design Rule - Definitions and Vehicle Categories) 2005*, Compilation 9 – 14 May 2016.

A two-character vehicle category code is shown for each vehicle category. This code is used to designate the relevant vehicles in the vehicle standards, as represented by the ADRs, and in related documentation.

4.2 Two-Wheeled and Three-Wheeled Vehicles

4.2.1. PEDAL CYCLE (AA)

A vehicle designed to be propelled through a mechanism solely by human power.

4.2.2. POWER-ASSISTED PEDAL CYCLE (AB)

A pedal cycle to which is attached one or more auxiliary propulsion motors having a combined maximum power output not exceeding 200 watts; or

A '*Pedalec*'.

4.2.3. MOPED - 2 Wheels (LA)

A 2-wheeled motor vehicle, not being a power-assisted pedal cycle, with an engine cylinder capacity not exceeding 50 ml and a '*Maximum Motor Cycle Speed*' not exceeding 50 km/h; or a 2-wheeled motor vehicle with a power source other than a piston engine and a '*Maximum Motor Cycle Speed*' not exceeding 50 km/h.

4.2.4. MOPED - 3 wheels (LB)

A 3-wheeled motor vehicle, not being a power-assisted pedal cycle, with an engine cylinder capacity not exceeding 50 ml and a '*Maximum Motor Cycle Speed*' not exceeding 50 km/h; or a 3-wheeled motor vehicle with a power source other than a piston engine and a '*Maximum Motor Cycle Speed*' not exceeding 50 km/h.

4.2.5. MOTOR CYCLE (LC)

A 2-wheeled motor vehicle with an engine cylinder capacity exceeding 50 ml or a '*Maximum Motor Cycle Speed*' exceeding 50 km/h.

4.2.6. MOTOR CYCLE AND SIDE-CAR (LD)

A motor vehicle with 3 wheels asymmetrically arranged in relation to the longitudinal median axis, with an engine cylinder capacity exceeding 50 ml or a '*Maximum Motor Cycle Speed*' exceeding 50 km/h.

4.2.7. SIDE-CAR

A car, box or other receptacle attached to the side of a motor cycle and for the support of which a wheel is provided.

4.2.8. MOTOR TRICYCLE (LE)

A motor vehicle with 3 wheels symmetrically arranged in relation to the longitudinal median axis, with a '*Gross Vehicle Mass*' not exceeding 1.0 tonne and either an engine cylinder capacity exceeding 50 ml or a '*Maximum Motor cycle Speed*' exceeding 50 km/h.

5. DETAILS OF SUB-CATEGORIES OF VEHICLE CATEGORIES

5.1. 3 Wheeled L-group Vehicles (LB)

LB1 one wheel at front, 2 at rear.

LB2 2 wheels at front, one at rear.

5.2. 3 Wheeled L-group Vehicles (LE)

LE1 one wheel at front, 2 at rear.

LE2 2 wheels at front, one at rear.

LEM1 the driver's '*Seat*' is of a saddle type and

one wheel at the front, 2 at rear.

LEM2 the driver's '*Seat*' is of a saddle type and

2 wheels at front, one at rear.

LEP1 the driver's '*Seat*' is not of a saddle type and/or

has more than two seating positions and/or

has a permanent structure to the rear of and

200 mm above the undeformed upper surface of the driver's '*Seat*' cushion and

one wheel at the front, 2 at rear.

LEP2 the driver's '*Seat*' is not of a saddle type and/or

has more than two seating positions and/or

has a permanent structure to the rear of and

200 mm above the undeformed upper surface of the driver's '*Seat*' cushion and

2 wheels at front, one at rear.

LEG1 constructed primarily for the carriage of goods and

one wheel at front, 2 at rear

a vehicle constructed for both the carriage of persons and the carriage of goods shall be considered to be primarily for the carriage of goods if the number of seating positions times 68 kg is less than 50 per cent of the difference between the '*Gross Vehicle Mass*' and the '*Unladen Mass*'.

LEG2 constructed primarily for the carriage of goods and

2 wheels at front, one at rear

a vehicle constructed for both the carriage of persons and the carriage of goods shall be considered to be primarily for the carriage of goods if the number of seating positions times 68 kg is less than 50 per cent of the difference between the '*Gross Vehicle Mass*' and the '*Unladen Mass*'.

APPENDIX 3—BENEFIT-COST ANALYSIS—DETAILS OF RESULTS

1. Establish the trend in new road motorcycle and scooter sales for analysis period. Extrapolate with 5 per cent growth, reduced for sustainability to 2 per cent growth from 15 years.

Table 18 New motorcycle sales 2003 to 2015 extrapolated to 2045 (FCAI, VFACTS).

Year	Road motorcycles	Scooters (approx.)	Total
2003	25500	3000	28500
2004	32220	3000	35220
2005	38802	3000	41802
2006	38510	3000	41510
2007	45510	3000	48510
2008	49347	4000	53347
2009	42372	4000	46372
2010	37968	4000	41968
2011	38628	4000	42628
2012	43613	5000	48613
2013	43883	5000	48883
2014	44530	5100	49630
2015	46757	5355	52112
2016	49094	5623	54717
2017	51549	5904	57453
2018	54126	6199	60326
2019	56833	6509	63342
2020	59674	6834	66509
2021	62658	7176	69834
2022	65791	7535	73326
2023	69081	7912	76992
2024	72535	8307	80842
2025	76161	8723	84884
2026	79969	9159	89128
2027	83968	9617	93585
2028	88166	10098	98264
2029	92575	10603	103177
2030	97203	11133	108336
2031	102064	11689	113753
2032	107167	12274	119441
2033	109310	12519	121829
2034	111496	12770	124266
2035	113726	13025	126751
2036	116001	13286	129286
2037	118321	13551	131872
2038	120687	13822	134509
2039	123101	14099	137200
2040	125563	14381	139944
2041	128074	14668	142742
2042	130636	14962	145597
2043	133248	15261	148509
2044	135913	15566	151479

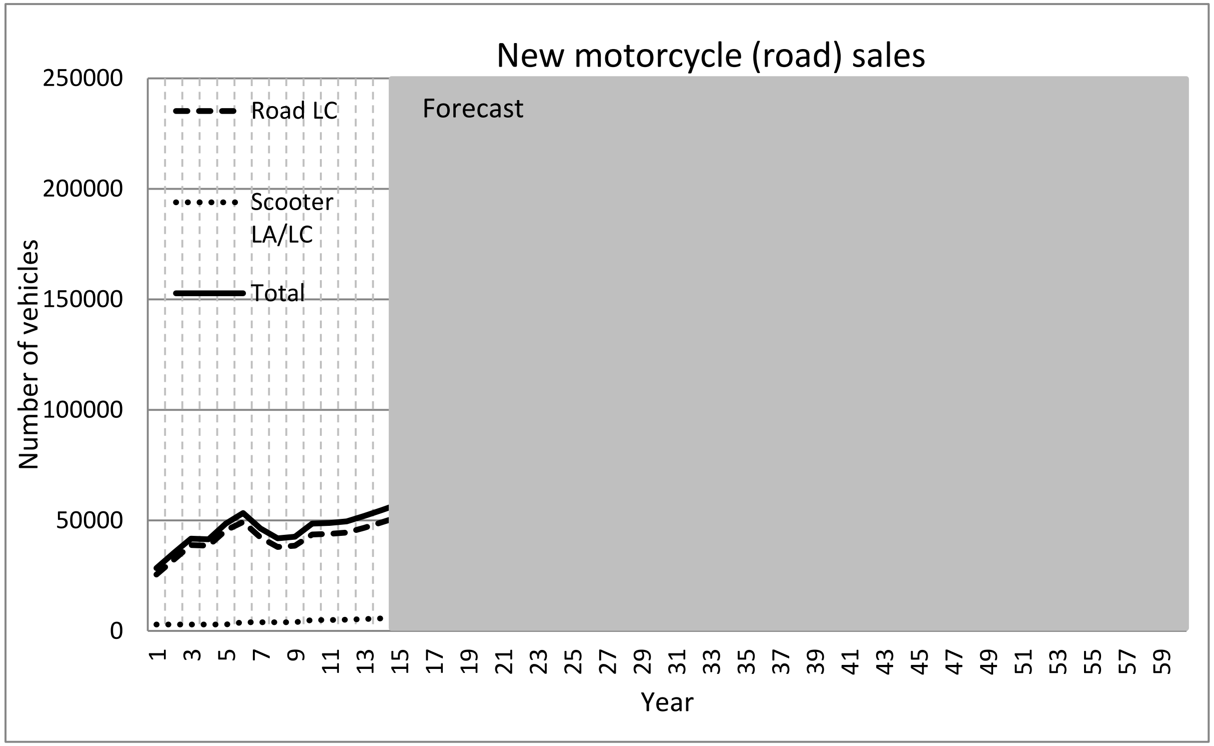

Figure 1 New vehicle sales from 2003 to 2035 (data from Table 20).

2. Establish the ratio of fatal to serious and minor motorcycle trauma crashes.

Trauma type	Vic	Qld	WA	SA	Total	Ratio
fatal	601	646	341	221	1809	**1**
serious injury	10890	9554	3869	1963	26276	**14.53**
minor injury	12376	7585	5691	4322	29974	**16.57**

Ratios are determined on available Australian data 2000-2011. A long period of accumulation removes annual inconsistencies and may not capture recent trends; i.e., ratios are conservative.

Type of Crash	Cost	Cost Year	Current $
Fatal	$3,878,686	2007	**$5,013,699**
Serious injury	$266,000	2006	**$352,779**
Minor injury	$14,700	2006	**$19,496**

Cost of trauma crash type converted to current $ [from Table 7.1 BITRE Report 102]

3. Establish crash frequency by age for motorcycles from registration and crash data.

Year	Australian registrations	New registrations
2015	807215	27041
2014	780174	35442
2013	744732	35444
2012	709288	30498
2011	678790	18683
2010	660107	36017
2009	624090	56521
2008	567569	55141
2007	512428	49371
2006	463057	41134
2005	421923	25623
2004	396300	19029
2003	377271	15123
2002	370982	11635
2001	350930	12394
2000	342365	7376
1999	333800	9755
1998	328800	9966
1997	313100	10724
1996	303900	7841
1995	296628	7056
1994	291800	6844
1993	291700	6639
1992	292400	6439
1991	284600	6246
1990	304000	6059
1989	316600	5877
1988	323300	5701
1987	351000	5530
1986	374500	5364
1985	389200	5201

Australian registrations. Data from ABS Motor Vehicle Census, cat. no. 9309.0, 1985–2015]

Motor-cycle age (years)	Casualty crash frequency Victoria 2010-2014	Annual casualty crashes in Australia (effective)	Annual casualty crash rate Australia	Annual new registrations Australia	Likelihood motorcycle at given age involved in casualty crash
0	294	280	0.000394	27041	**0.008477**
1	909	864	0.001218	35442	**0.019997**
2	973	925	0.001304	35444	**0.021404**
3	847	805	0.001135	30498	**0.021654**
4	774	736	0.001037	18683	**0.032301**
5	663	630	0.000889	36017	**0.014353**
6	601	571	0.000806	56521	**0.008291**
7	456	434	0.000611	55141	**0.006448**
8	381	362	0.000511	49371	**0.006017**
9	298	283	0.000399	41134	**0.005649**
10	309	294	0.000414	25623	**0.009403**
11	216	205	0.000290	19029	**0.008850**
12	239	227	0.000320	15123	**0.012322**
13	176	167	0.000236	11635	**0.011794**
14	176	167	0.000236	12394	**0.011072**
15	134	127	0.000180	7377	**0.014164**
16	109	104	0.000146	9755	**0.008712**
17	100	95	0.000134	9967	**0.007823**
18	80	76	0.000107	10724	**0.005816**
19	86	82	0.000115	7842	**0.008551**
20	89	85	0.000119	7056	**0.009835**
21	68	65	0.000091	6844	**0.007746**
22	69	66	0.000092	6639	**0.008104**
23	69	66	0.000092	6440	**0.008354**
24	44	42	0.000059	6247	**0.005492**
25	42	40	0.000056	6059	**0.005405**
26	31	29	0.000042	5877	**0.004112**
27	21	20	0.000028	5701	**0.002872**
28	21	20	0.000028	5530	**0.002961**
29	11	10	0.000015	5364	**0.001599**
30	13	12	0.000017	5202	**0.001949**
>30	136	129	0.000182		

Frequency data from Victoria (Vicroads) for Fatalities and injuries 2010-2014

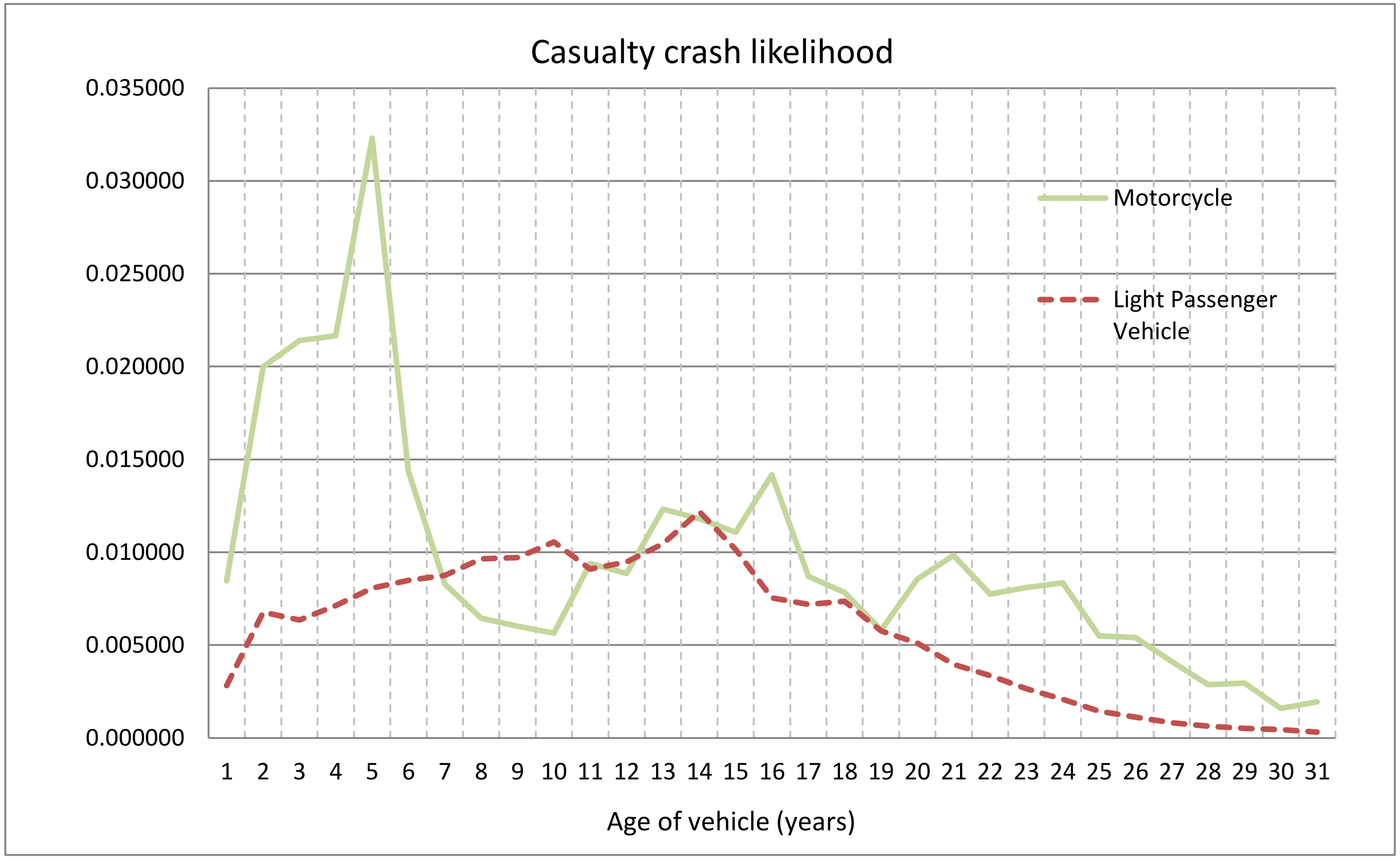

Figure 2 - Crash likelihood by vehicle age

4. Establish expected fitment rates for each option (data to 2050 shown).

Year	BAU	Option 2a	Option 2b	Option 6a,b
2004	0.010	0.010	0.010	0.010
2005	0.015	0.015	0.015	0.015
2006	0.010	0.010	0.010	0.010
2007	0.005	0.005	0.005	0.005
2008	0.030	0.030	0.030	0.030
2009	0.050	0.050	0.050	0.050
2010	0.090	0.090	0.090	0.090
2011	0.110	0.110	0.110	0.110
2012	0.200	0.200	0.200	0.200
2013	0.360	0.360	0.360	0.360
2014	0.270	0.270	0.270	0.270
2015	0.330	0.330	0.330	0.330
2016	0.410	0.410	0.410	0.410
2017	0.510	0.510	0.510	0.510
2018	0.600	0.770	0.643	0.750
2019	0.680	0.811	0.724	0.999
2020	0.750	0.832	0.794	0.999
2021	0.810	0.853	0.853	0.999
2022	0.855	0.874	0.895	0.999
2023	0.890	0.894	0.928	0.999
2024	0.915	0.915	0.950	0.999
2025	0.925	0.925	0.950	0.999
2026	0.926	0.926	0.950	0.999
2027	0.926	0.926	0.950	0.999
2028	0.927	0.927	0.950	0.999
2029	0.928	0.928	0.950	0.999
2030	0.928	0.928	0.950	0.999
2031	0.929	0.929	0.950	0.999
2032	0.930	0.930	0.950	0.999
2033	0.930	0.930	0.950	0.990
2034	0.931	0.931	0.950	0.985
2035	0.932	0.932	0.950	0.980
2036	0.932	0.932	0.950	0.975
2037	0.933	0.933	0.950	0.970
2038	0.934	0.934	0.950	0.965
2039	0.934	0.934	0.950	0.960
2040	0.935	0.935	0.950	0.955
2041	0.936	0.936	0.950	0.950
2042	0.936	0.936	0.950	0.950
2043	0.937	0.937	0.950	0.950
2044	0.938	0.938	0.950	0.950
2045	0.939	0.939	0.950	0.950
2046	0.939	0.939	0.950	0.950
2047	0.940	0.940	0.950	0.950
2048	0.941	0.941	0.950	0.950
2049	0.941	0.941	0.950	0.950
2050	0.942	0.942	0.950	0.950

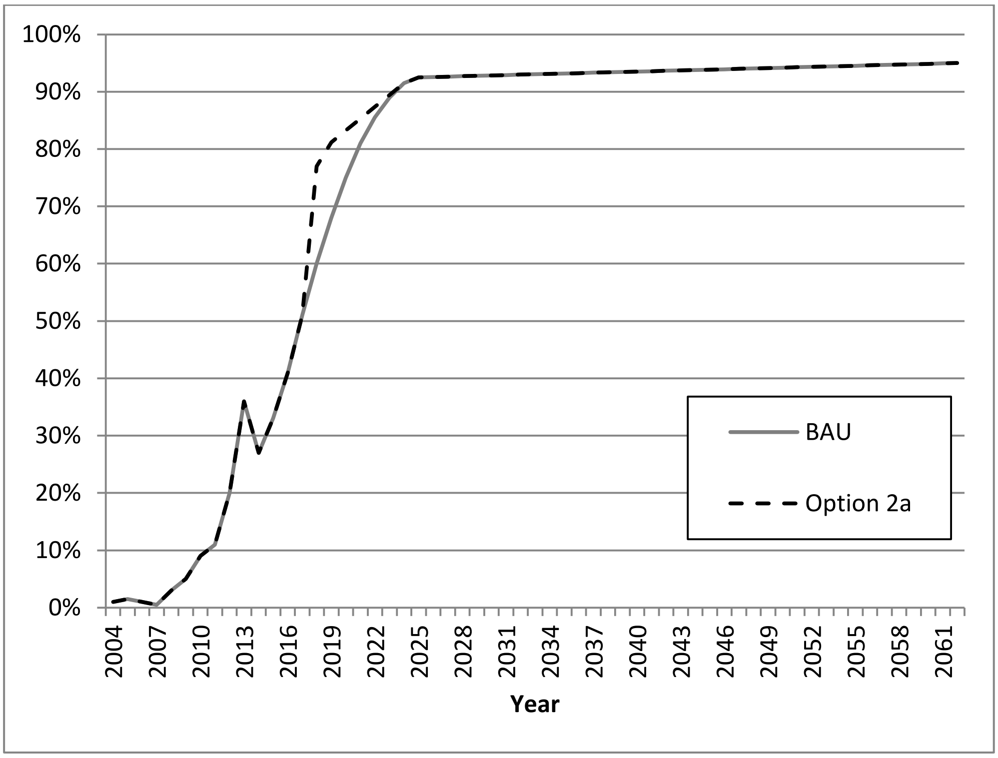

Figure 16 - Option 2a fitment

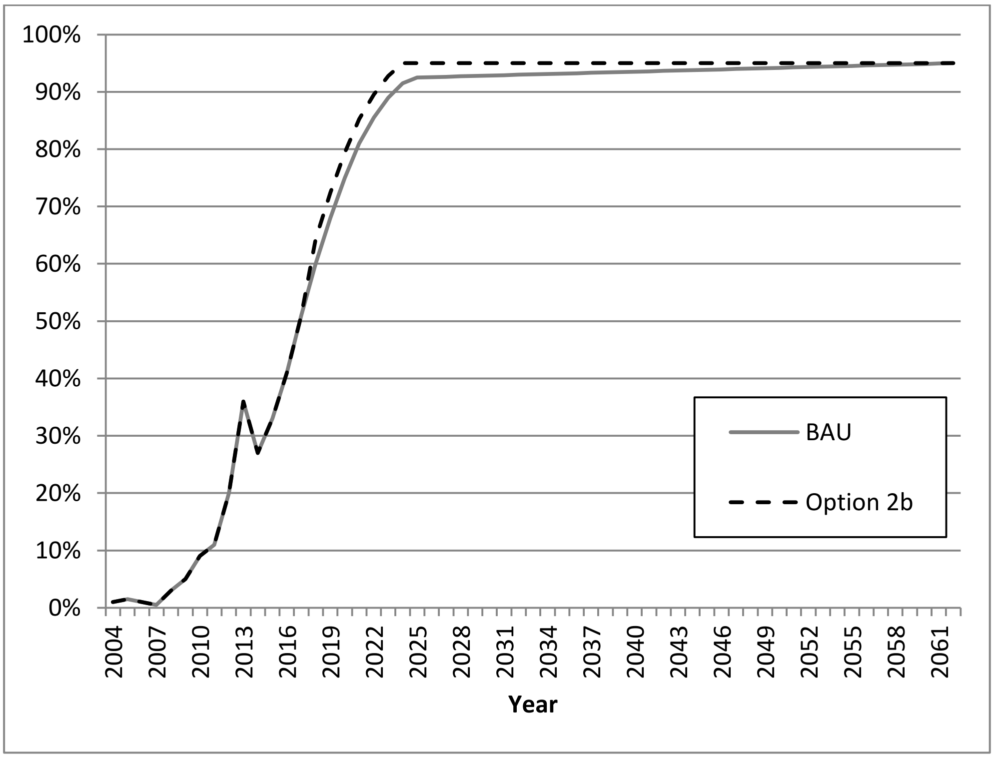

Figure 17 - Option 2b fitment

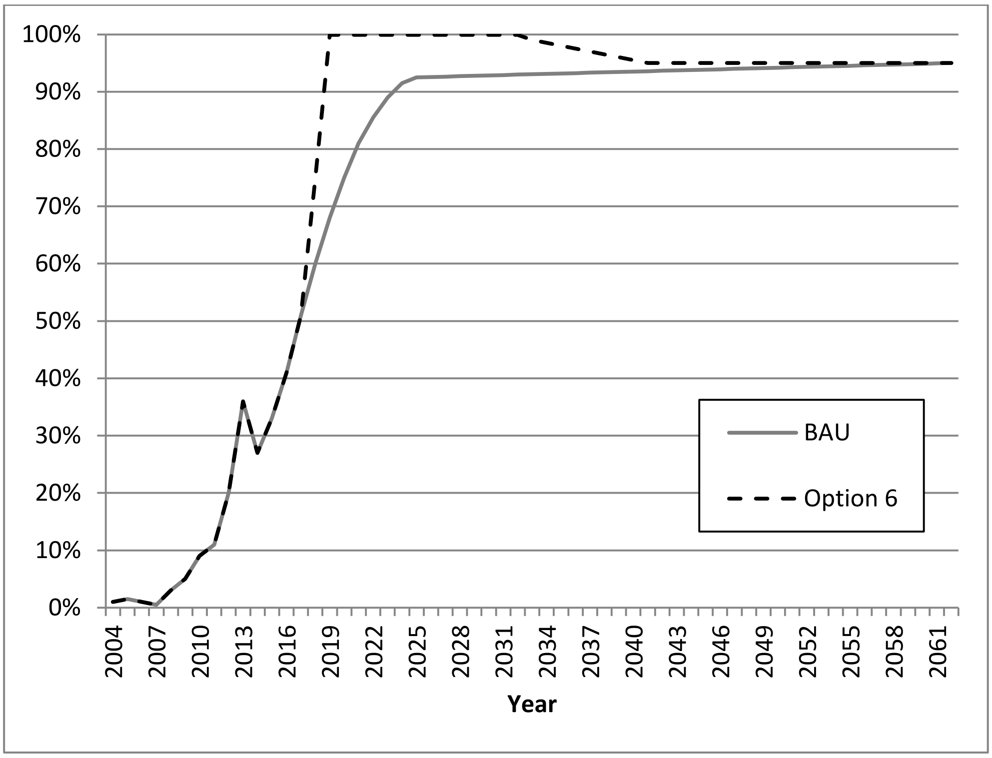

Figure 18 - Option 6a,b fitment

5. For each viable option, estimate the number of motorcyclist fatalities and injuries that will be prevented for each year due to new motorcycles entering the fleet with advanced braking systems, using the probability mass distributions established in step 6, the vehicle registration trends established in step 7, the fitment rates established in step 8, and effectiveness and crash/fleet relevance as per Table 18.

Table 19 – Established general analysis parameters

Technology	Effectiveness
ABS LC>=125 all injury	**0.33**
ABS LC>=125 KSI	0.39
CBS LC/LA<125 all injury	0.24
CBS LC/LA<125 KSI	0.28
LC ABS/CBS crash relevance	0.93
Proportion Australian fleet CBS eligible	0.05

5.1 **Option 2a** ('likely case' data for first 30 years shown)

Determine fitment increase by year due to Option 2a intervention

Year		Vehicle Sales	Fitment at Sale via Option	BAU Fitment at Sale	Fitment Increase at Sale
1	2018	60,326	46,450.69	36,195.35	10,255
2	2019	63,342	51,397.39	43,072.46	8,325
3	2020	66,509	55,344.94	49,881.71	5,463
4	2021	69,834	59,558.76	56,565.86	2,993
5	2022	73,326	64,055.60	62,693.83	1,362
6	2023	76,992	68,853.22	68,523.25	330
7	2024	80,842	73,970.47	73,970.47	-
8	2025	84,884	78,517.83	78,517.83	-
9	2026	89,128	82,503.95	82,503.95	-
10	2027	93,585	86,692.38	86,692.38	-
11	2028	98,264	91,093.39	91,093.39	-
12	2029	103,177	95,717.77	95,717.77	-
13	2030	108,336	100,576.86	100,576.86	-
14	2031	113,753	105,682.56	105,682.56	-
15	2032	119,441	111,047.40	111,047.40	-
16	2033	121,829	113,350.66	113,350.66	-
17	2034	124,266	115,701.64	115,701.64	-
18	2035	126,751	118,101.31	118,101.31	-
19	2036	129,286	120,550.69	120,550.69	-
20	2037	131,872	123,050.81	123,050.81	-
21	2038	134,509	125,602.71	125,602.71	-
22	2039	137,200	128,207.47	128,207.47	-
23	2040	139,944	130,866.17	130,866.17	-
24	2041	142,742	133,579.95	133,579.95	-
25	2042	145,597	136,349.92	136,349.92	-
26	2043	148,509	139,177.26	139,177.26	-
27	2044	151,479	142,063.16	142,063.16	-
28	2045	154,509	145,008.82	145,008.82	-
29	2046	157,599	148,015.48	148,015.48	-
30	2047	160,751	151,084.41	151,084.41	-

Determine total crashes alleviated by year as fitted (due to intervention) motorcycles are bought and penetrate the fleet over time. Multiply crash likelihood for motorcycle's age by annual fitment increase each year, summating over motorcycles of all ages for each year)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Vehicles
1	87																														87
2	205	71																													276
3	220	166	46																												432
4	222	178	109	25																											535
5	331	180	117	60	12																										700
6	147	269	118	64	27	3																									628
7	85	119	176	65	29	7	0																								482
8	66	69	78	97	29	7	0	0																							347
9	62	54	45	43	44	7	0	0	0																						255
10	58	50	35	25	20	11	0	0	0	0																					198
11	96	47	33	19	11	5	0	0	0	0	0																				212
12	91	78	31	18	9	3	0	0	0	0	0	0																			229
13	126	74	51	17	8	2	0	0	0	0	0	0	0																		279
14	121	103	48	28	8	2	0	0	0	0	0	0	0	0																	310
15	114	98	67	26	13	2	0	0	0	0	0	0	0	0	0																320
16	145	92	64	37	12	3	0	0	0	0	0	0	0	0	0	0															354
17	89	118	60	35	17	3	0	0	0	0	0	0	0	0	0	0	0														323
18	80	73	77	33	16	4	0	0	0	0	0	0	0	0	0	0	0	0													283
19	60	65	48	42	15	4	0	0	0	0	0	0	0	0	0	0	0	0	0												234
20	88	48	43	26	19	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0											228
21	101	71	32	23	12	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										244
22	79	82	47	17	11	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									239
23	83	64	54	26	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								237
24	86	67	42	29	12	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							238
25	56	70	44	23	13	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						210
26	55	46	46	24	11	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					185
27	42	45	30	25	11	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				156
28	29	34	30	16	11	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			124
29	30	24	22	16	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		103
30	16	25	16	12	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78

Determine motorcyclist trauma alleviated by year

Year		Crashes alleviated	Fatal	Major	Minor
1	2018	87	0.97	11.91	13.58
2	2019	276	3.07	37.75	43.07
3	2020	432	4.82	59.21	67.54
4	2021	535	5.96	73.26	83.57
5	2022	700	7.80	95.86	109.35
6	2023	628	7.00	86.08	98.20
7	2024	482	5.37	65.95	75.24
8	2025	347	3.86	47.50	54.18
9	2026	255	2.84	34.89	39.81
10	2027	198	2.21	27.16	30.98
11	2028	212	2.36	28.99	33.07
12	2029	229	2.56	31.42	35.85
13	2030	279	3.11	38.16	43.54
14	2031	310	3.45	42.42	48.39
15	2032	320	3.57	43.86	50.03
16	2033	354	3.94	48.47	55.29
17	2034	323	3.60	44.20	50.43
18	2035	283	3.16	38.82	44.28
19	2036	234	2.60	32.01	36.52
20	2037	228	2.54	31.21	35.60
21	2038	244	2.72	33.39	38.09
22	2039	239	2.66	32.73	37.34
23	2040	237	2.65	32.52	37.09
24	2041	238	2.66	32.66	37.26
25	2042	210	2.34	28.70	32.74
26	2043	185	2.06	25.32	28.88
27	2044	156	1.74	21.33	24.34
28	2045	124	1.38	16.94	19.33
29	2046	103	1.15	14.13	16.12
30	2047	78	0.87	10.71	12.22

Total lives saved over 35-year run-out period: 97.

Determine costs and savings over BAU by year

Year		Crashes alleviated	Trauma savings $	Fitment costs over BAU	Increase development cost	Government costs	Net $ (savings less costs)
1	2018	87	8,360,076	-		3,000,000	822,085
2	2019	276	26,507,524	-		3,000,000	19,823,742
3	2020	432	41,570,907	-		3,000,000	36,153,426
4	2021	535	51,435,611	-		3,000,000	47,111,252
5	2022	700	67,300,706	-		3,000,000	63,698,123
6	2023	628	60,437,440	-		3,000,000	57,291,429
7	2024	482	46,305,753	-			46,305,753
8	2025	347	33,347,653	-			33,347,653
9	2026	255	24,499,184	-			24,499,184
10	2027	198	19,065,550	-			19,065,550
11	2028	212	20,352,825	-			20,352,825
12	2029	229	22,062,296	-			22,062,296
13	2030	279	26,794,990	-			26,794,990
14	2031	310	29,781,842	-			29,781,842
15	2032	320	30,791,995	-			30,791,995
16	2033	354	34,031,383	-			34,031,383
17	2034	323	31,036,067	-			31,036,067
18	2035	283	27,252,542	-			27,252,542
19	2036	234	22,476,425	-			22,476,425
20	2037	228	21,912,387	-			21,912,387
21	2038	244	23,441,596	-			23,441,596
22	2039	239	22,979,685	-			22,979,685
23	2040	237	22,830,587	-			22,830,587
24	2041	238	22,930,440	-			22,930,440
25	2042	210	20,149,997	-			20,149,997
26	2043	185	17,774,167	-			17,774,167
27	2044	156	14,978,860	-			14,978,860
28	2045	124	11,895,623	-			11,895,623
29	2046	103	9,919,347	-			9,919,347
30	2047	78	7,521,497	-			7,521,497

Determine NPV benefits and costs and benefit-cost ratios (35-year runout period, best and worst case included for comparison)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio
Best Case	$371,705,566	$7,312,887	$14,299,619	18.2
Likely Case	$368,049,122	$10,969,330	$14,299,619	15.6
Worst Case	$364,392,679	$14,625,773	$14,299,619	13.6

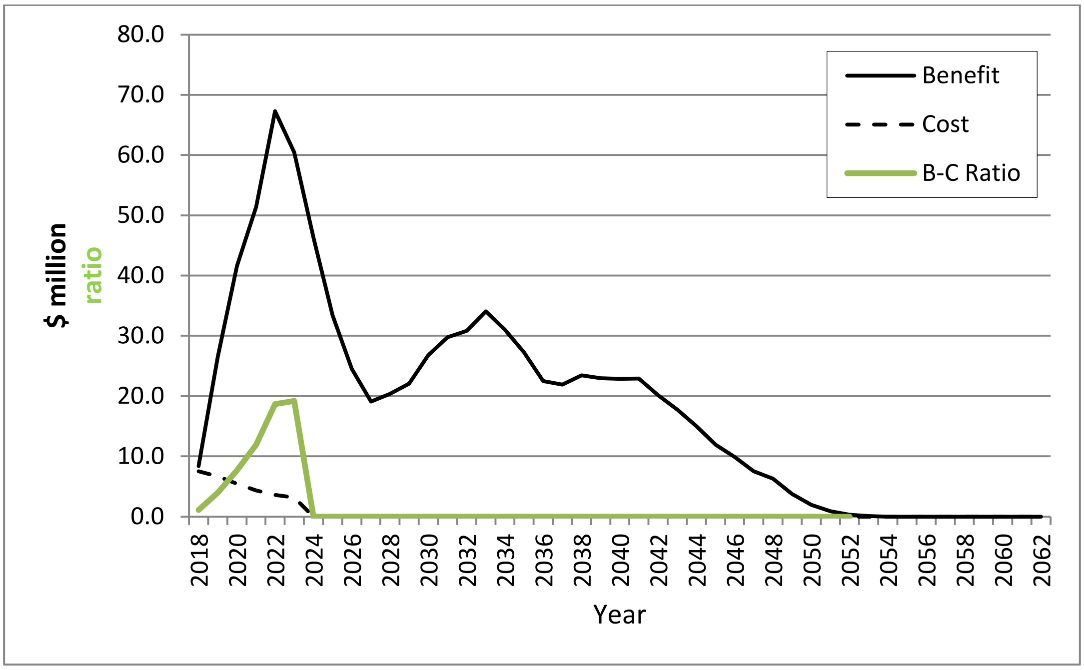

Figure 19 - Option 2a Benefits, Costs and BCR run-out

5.2 **Option 2b** ('likely case' data for first 30 years shown)

Determine fitment increase by year due to Option 2b intervention.

Year		Vehicle Sales	Fitment at Sale via Option	BAU Fitment at Sale	Fitment Increase at Sale
1	2018	60,326	38,801.41	36,195.35	2,606
2	2019	63,342	45,863.56	43,072.46	2,791
3	2020	66,509	52,790.81	49,881.71	2,909
4	2021	69,834	59,534.89	56,565.86	2,969
5	2022	73,326	65,655.43	62,693.83	2,962
6	2023	76,992	71,436.54	68,523.25	2,913
7	2024	80,842	76,800.85	73,970.47	2,830
8	2025	84,884	80,639.94	78,517.83	2,122
9	2026	89,128	84,671.93	82,503.95	2,168
10	2027	93,585	88,905.53	86,692.38	2,213
11	2028	98,264	93,350.81	91,093.39	2,257
12	2029	103,177	98,018.35	95,717.77	2,301
13	2030	108,336	102,919.26	100,576.86	2,342
14	2031	113,753	108,065.23	105,682.56	2,383
15	2032	119,441	113,468.49	111,047.40	2,421
16	2033	121,829	115,737.86	113,350.66	2,387
17	2034	124,266	118,052.61	115,701.64	2,351
18	2035	126,751	120,413.67	118,101.31	2,312
19	2036	129,286	122,821.94	120,550.69	2,271
20	2037	131,872	125,278.38	123,050.81	2,228
21	2038	134,509	127,783.95	125,602.71	2,181
22	2039	137,200	130,339.62	128,207.47	2,132
23	2040	139,944	132,946.42	130,866.17	2,080
24	2041	142,742	135,605.35	133,579.95	2,025
25	2042	145,597	138,317.45	136,349.92	1,968
26	2043	148,509	141,083.80	139,177.26	1,907
27	2044	151,479	143,905.48	142,063.16	1,842
28	2045	154,509	146,783.59	145,008.82	1,775
29	2046	157,599	149,719.26	148,015.48	1,704
30	2047	160,751	152,713.64	151,084.41	1,629

Determine total crashes alleviated by year as fitted (due to intervention) motorcycles are bought and penetrate the fleet over time. Multiply crash likelihood for motorcycle's age by annual fitment increase each year, summating over motorcycles of all ages for each year).

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Vehicles
1	22																														22
2	52	24																													76
3	56	56	25																												136
4	56	60	58	25																											200
5	84	60	62	59	25																										291
6	37	90	63	64	59	25																									338
7	22	40	94	64	63	58	24																								366
8	17	23	42	96	64	62	57	18																							379
9	16	18	24	43	96	63	61	42	18																						381
10	15	17	19	25	43	94	61	45	43	19																					380
11	25	16	18	19	25	42	91	46	46	44	19																				390
12	23	26	16	18	19	24	41	69	47	47	45	20																			395
13	32	25	27	17	18	19	23	30	70	48	48	46	20																		424
14	31	34	26	28	17	18	18	18	31	71	49	49	47	20																	457
15	29	33	36	26	28	16	17	14	18	32	73	50	50	48	21																490
16	37	31	34	37	26	27	16	13	14	18	32	74	51	51	48	20															530
17	23	40	32	35	36	26	27	12	13	14	19	33	76	52	52	48	20														556
18	20	24	41	33	35	36	25	20	12	13	15	19	34	77	52	51	47	20													575
19	15	22	25	42	33	34	35	19	20	13	14	15	19	34	78	52	50	46	19												586
20	22	16	23	26	42	32	33	26	19	21	13	14	15	20	35	77	51	49	45	19											599
21	26	24	17	23	26	41	31	25	27	20	21	13	14	15	20	34	76	50	49	45	18										615
22	20	27	25	17	23	25	40	23	26	27	20	22	13	14	16	20	34	75	49	48	44	18									626
23	21	22	29	25	17	23	25	30	24	26	28	20	22	13	15	15	19	33	73	48	47	43	18								636
24	22	23	23	29	25	17	22	18	31	25	27	28	21	22	14	14	15	19	33	72	47	46	42	17							651
25	14	23	24	23	29	25	16	17	19	31	25	27	29	21	23	13	14	15	19	32	70	46	45	41	17						658
26	14	15	24	24	23	29	24	12	17	19	32	25	28	29	21	22	13	14	15	18	31	69	45	43	39	16					665
27	11	15	16	25	24	23	28	18	13	17	20	33	26	28	30	21	22	13	14	14	18	31	67	44	42	38	16				665
28	7	11	16	16	25	24	22	21	19	13	18	20	33	26	29	29	21	22	13	13	14	18	30	65	43	41	37	15			660
29	8	8	12	16	16	24	23	16	21	19	13	18	20	34	27	28	29	20	21	13	13	14	17	29	64	41	39	35	14		655
30	4	8	8	12	16	16	24	17	17	22	19	13	18	21	34	26	28	28	20	21	12	13	13	17	28	62	40	38	34	14	645

Determine motorcyclist trauma alleviated by year

Year		Crashes alleviated	Fatal	Major	Minor
1	2018	22	0.25	3.03	3.45
2	2019	76	0.84	10.38	11.84
3	2020	136	1.52	18.66	21.29
4	2021	200	2.22	27.33	31.17
5	2022	291	3.25	39.91	45.52
6	2023	338	3.77	46.30	52.81
7	2024	366	4.07	50.07	57.12
8	2025	379	4.22	51.87	59.17
9	2026	381	4.24	52.12	59.46
10	2027	380	4.24	52.09	59.42
11	2028	390	4.35	53.48	61.01
12	2029	395	4.40	54.10	61.71
13	2030	424	4.72	58.02	66.18
14	2031	457	5.09	62.55	71.35
15	2032	490	5.46	67.07	76.51
16	2033	530	5.91	72.66	82.88
17	2034	556	6.20	76.17	86.89
18	2035	575	6.40	78.69	89.76
19	2036	586	6.53	80.24	91.53
20	2037	599	6.67	82.03	93.57
21	2038	615	6.85	84.24	96.10
22	2039	626	6.98	85.79	97.86
23	2040	636	7.09	87.17	99.44
24	2041	651	7.25	89.15	101.70
25	2042	658	7.33	90.13	102.82
26	2043	665	7.41	91.06	103.88
27	2044	665	7.41	91.10	103.92
28	2045	660	7.35	90.38	103.10
29	2046	655	7.30	89.71	102.33
30	2047	645	7.19	88.36	100.79

Total lives saved over 35-year run-out period: 190.

Determine costs and savings over BAU by year

Year		Crashes alleviated	Trauma savings $	Fitment costs over BAU	Increase development cost	Government costs	Net $ (savings less costs)
1	2018	3.45	2,124,443	1,153,184	-	9,000,000	-8,028,741
2	2019	11.84	7,286,760	1,235,060	-	9,000,000	-2,948,300
3	2020	21.29	13,102,795	1,287,277	-	9,000,000	2,815,518
4	2021	31.17	19,186,079	1,313,795	-	9,000,000	8,872,283
5	2022	45.52	28,018,414	1,310,511	-	9,000,000	17,707,903
6	2023	52.81	32,505,450	1,289,129	-	9,000,000	22,216,321
7	2024	57.12	35,154,101	1,252,447	-	9,000,000	24,901,654
8	2025	59.17	36,414,808	939,031	-	9,000,000	26,475,777
9	2026	59.46	36,595,298	959,334	-	9,000,000	26,635,963
10	2027	59.42	36,573,135	979,320	-	9,000,000	26,593,815
11	2028	61.01	37,547,878	998,907	-	9,000,000	27,548,971
12	2029	61.71	37,983,133	1,018,003	-	9,000,000	27,965,129
13	2030	66.18	40,734,666	1,036,513	-	9,000,000	30,698,153
14	2031	71.35	43,913,989	1,054,328	-	9,000,000	33,859,662
15	2032	76.51	47,090,430	1,071,333	-	9,000,000	37,019,097
16	2033	82.88	51,012,745	-	-	-	51,012,745
17	2034	86.89	53,479,655	-	-	-	53,479,655
18	2035	89.76	55,247,881	-	-	-	55,247,881
19	2036	91.53	56,335,236	-	-	-	56,335,236
20	2037	93.57	57,590,864	-	-	-	57,590,864
21	2038	96.10	59,145,113	-	-	-	59,145,113
22	2039	97.86	60,229,375	-	-	-	60,229,375
23	2040	99.44	61,201,515	-	-	-	61,201,515
24	2041	101.70	62,592,491	-	-	-	62,592,491
25	2042	102.82	63,280,749	-	-	-	63,280,749
26	2043	103.88	63,933,910	-	-	-	63,933,910
27	2044	103.92	63,957,480	-	-	-	63,957,480
28	2045	103.10	63,456,050	-	-	-	63,456,050
29	2046	102.33	62,984,398	-	-	-	62,984,398
30	2047	100.79	62,034,852	-	-	-	62,034,852

Determine NPV benefits and costs and benefit-cost ratios (35-year runout period, best and worst case included for comparison)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio
Best Case	$378,671,629	$7,001,984	$81,971,226	5.3
Likely Case	$375,170,637	$10,502,976	$81,971,226	5.1
Worst Case	$371,669,645	$14,003,968	$81,971,226	4.9

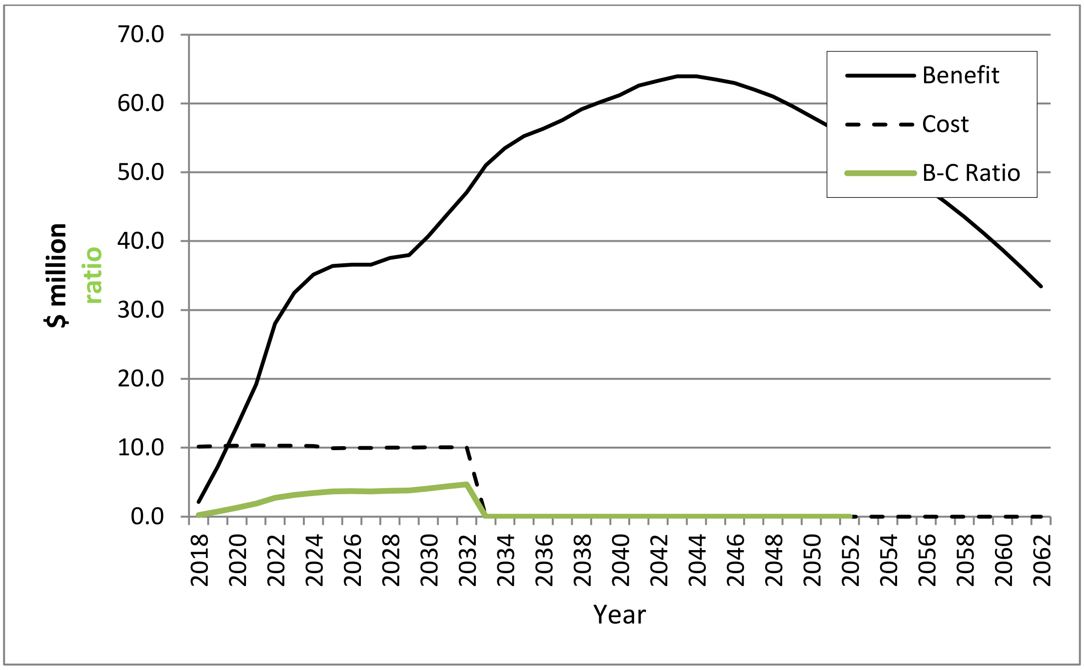

Figure 20 - Option 2b Benefits, Costs and BCR run-out

5.3 Option 6a ('likely case' data for first 30 years shown)

Determine fitment increase by year due to Option 6a intervention.

Year		Vehicle Sales	Fitment at Sale via Option	BAU Fitment at Sale	Fitment Increase at Sale
1	2018	54,126	40,594.87	32,475.90	8,119
2	2019	56,833	56,775.99	38,646.32	18,130
3	2020	59,674	59,614.78	44,755.84	14,859
4	2021	62,658	62,595.52	50,753.13	11,842
5	2022	65,791	65,725.30	56,251.38	9,474
6	2023	69,081	69,011.56	61,481.77	7,530
7	2024	72,535	72,462.14	66,369.23	6,093
8	2025	76,161	76,085.25	70,449.31	5,636
9	2026	79,969	79,889.51	74,025.80	5,864
10	2027	83,968	83,883.99	77,783.83	6,100
11	2028	88,166	88,078.19	81,732.59	6,346
12	2029	92,575	92,482.10	85,881.77	6,600
13	2030	97,203	97,106.20	90,241.54	6,865
14	2031	102,064	101,961.51	94,822.58	7,139
15	2032	107,167	107,059.59	99,636.12	7,423
16	2033	109,310	108,217	101,702.70	6,514
17	2034	111,496	109,824	103,812.09	6,012
18	2035	113,726	111,452	105,965.17	5,487
19	2036	116,001	113,101	108,162.85	4,938
20	2037	118,321	114,771	110,406.06	4,365
21	2038	120,687	116,463	112,695.72	3,767
22	2039	123,101	118,177	115,032.81	3,144
23	2040	125,563	119,913	117,418.31	2,494
24	2041	128,074	121,670	119,853.21	1,817
25	2042	130,636	124,104	122,338.54	1,765
26	2043	133,248	126,586	124,875.35	1,711
27	2044	135,913	129,118	127,464.69	1,653
28	2045	138,632	131,700	130,107.65	1,592
29	2046	141,404	134,334	132,805.35	1,529
30	2047	144,232	137,021	135,558.91	1,462

Determine total crashes alleviated by year as fitted (due to intervention) motorcycles are bought and penetrate the fleet over time. Multiply crash likelihood for motorcycle's age by annual fitment increase each year, summating over motorcycles of all ages for each year).

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Vehicles
1	69																														69
2	162	154																													316
3	174	363	126																												662
4	176	388	297	100																											961
5	262	393	318	237	80																										1290
6	117	586	322	253	189	64																									1531
7	67	260	480	256	203	151	52																								1469
8	52	150	213	383	205	161	122	48																							1334
9	49	117	123	170	306	163	130	113	50																						1221
10	46	109	96	98	136	243	132	121	117	52																					1150
11	76	102	89	76	79	108	197	122	126	122	54																				1151
12	72	170	84	71	61	62	87	182	127	131	127	56																			1231
13	100	160	140	67	57	49	51	81	189	132	136	132	58																		1352
14	96	223	132	111	54	45	39	47	84	197	137	141	137	61																	1505
15	90	214	183	105	89	43	37	36	49	88	205	143	147	143	63																1633
16	115	201	175	146	84	71	34	34	38	51	91	213	149	153	148	55															1758
17	71	257	165	140	117	67	57	32	35	39	53	95	222	155	159	130	51														1843
18	64	158	210	131	112	93	54	53	33	37	41	55	99	231	161	139	120	47													1836
19	47	142	129	168	105	89	75	50	55	34	38	43	57	102	240	141	129	110	42												1796
20	69	105	116	103	134	83	72	69	52	57	36	40	44	59	107	210	130	117	99	37											1742
21	80	155	86	93	83	107	67	66	72	54	60	37	41	46	62	93	194	119	106	87	32										1741
22	63	178	127	69	74	66	86	62	69	75	56	62	39	43	48	54	86	177	107	93	75	27									1738
23	66	140	146	101	55	59	53	80	65	72	78	58	65	40	45	42	50	79	160	95	81	63	21								1713
24	68	147	115	116	81	44	48	49	83	68	75	81	61	67	42	39	39	45	71	141	82	67	50	15							1694
25	45	151	120	92	93	64	35	44	51	86	70	78	85	63	70	37	36	35	41	63	122	68	53	36	15						1655
26	44	100	124	96	73	74	52	33	46	53	90	73	81	88	66	61	34	33	32	36	54	102	54	39	35	15					1587
27	33	98	82	99	77	58	60	48	34	48	55	93	76	84	91	58	57	31	30	28	31	45	81	39	38	34	14				1523
28	23	75	80	65	79	61	47	55	50	35	50	58	97	79	88	80	53	52	28	26	24	26	36	59	38	37	33	13			1448
29	24	52	61	64	52	63	49	44	58	52	37	52	60	101	82	77	74	49	46	25	23	20	21	26	57	37	35	32	13		1385
30	13	54	43	49	51	41	51	46	45	60	54	38	54	62	105	72	71	68	44	41	21	19	16	15	25	55	36	34	31	12	1326

Determine motorcyclist trauma alleviated by year

Year		Crashes alleviated	Fatal	Major	Minor
1	2018	69	0.78	11.30	10.90
2	2019	316	3.57	51.88	50.08
3	2020	662	7.48	108.71	104.93
4	2021	961	10.86	157.81	152.32
5	2022	1290	14.58	211.75	204.39
6	2023	1531	17.30	251.26	242.52
7	2024	1469	16.60	241.12	232.74
8	2025	1334	15.08	219.04	211.42
9	2026	1221	13.80	200.39	193.43
10	2027	1150	12.99	188.72	182.16
11	2028	1151	13.01	188.98	182.41
12	2029	1231	13.91	202.05	195.03
13	2030	1352	15.27	221.86	214.15
14	2031	1505	17.00	246.96	238.38
15	2032	1633	18.45	268.04	258.72
16	2033	1758	19.86	288.52	278.49
17	2034	1843	20.82	302.46	291.95
18	2035	1836	20.75	301.37	290.90
19	2036	1796	20.29	294.76	284.52
20	2037	1742	19.68	285.90	275.97
21	2038	1741	19.67	285.71	275.78
22	2039	1738	19.64	285.22	275.30
23	2040	1713	19.36	281.16	271.38
24	2041	1694	19.14	278.06	268.39
25	2042	1655	18.70	271.64	262.20
26	2043	1587	17.94	260.51	251.46
27	2044	1523	17.21	249.95	241.26
28	2045	1448	16.36	237.70	229.44
29	2046	1385	15.65	227.37	219.47
30	2047	1326	14.99	217.73	210.16

Total lives saved over 35-year run-out period: 534.

Determine costs and savings over BAU by year

Year		Crashes alleviated	Trauma savings $	Fitment costs over BAU	Increase development cost	Government costs	Net $ (savings less costs)
1	2018	69	6,618,522	3,653,538	356,932	50,000	2,558,052
2	2019	316	30,392,005	8,158,351	333,136	50,000	21,850,518
3	2020	662	63,687,531	6,686,523	309,341	50,000	56,641,667
4	2021	961	92,449,987	5,329,078	285,545	50,000	86,785,363
5	2022	1,290	124,050,928	4,263,263	261,750	50,000	119,475,915
6	2023	1,531	147,192,905	3,388,406	237,955	50,000	143,516,545
7	2024	1,469	141,256,720	2,741,811	214,159	50,000	138,250,750
8	2025	1,334	128,318,617	2,536,175	190,364	50,000	125,542,079
9	2026	1,221	117,396,578	2,638,669	166,568	50,000	114,541,341
10	2027	1,150	110,556,369	2,745,071	142,773	50,000	107,618,525
11	2028	1,151	110,709,557	2,855,518	118,977	50,000	107,685,062
12	2029	1,231	118,368,547	2,970,146	95,182	50,000	115,253,220
13	2030	1,352	129,971,020	3,089,098	71,386	50,000	126,760,535
14	2031	1,505	144,679,108	3,212,520	47,591	50,000	141,368,997
15	2032	1,633	157,026,155	3,340,562	23,795	50,000	153,611,798
16	2033	1,758	169,021,206	-	-	-	169,021,206
17	2034	1,843	177,191,226	-	-	-	177,191,226
18	2035	1,836	176,552,624	-	-	-	176,552,624
19	2036	1,796	172,680,447	-	-	-	172,680,447
20	2037	1,742	167,490,972	-	-	-	167,490,972
21	2038	1,741	167,375,377	-	-	-	167,375,377
22	2039	1,738	167,087,560	-	-	-	167,087,560
23	2040	1,713	164,710,531	-	-	-	164,710,531
24	2041	1,694	162,893,748	-	-	-	162,893,748
25	2042	1,655	159,134,556	-	-	-	159,134,556
26	2043	1,587	152,616,768	-	-	-	152,616,768
27	2044	1,523	146,428,380	-	-	-	146,428,380
28	2045	1,448	139,251,003	-	-	-	139,251,003
29	2046	1,385	133,202,173	-	-	-	133,202,173
30	2047	1,326	127,553,583	-	-	-	127,553,583

Determine NPV benefits and costs and benefit-cost ratios (35-year runout period, best and worst case included for comparison)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio
Best Case	$1,465,101,952	$26,528,438	$455,396	55.3
Likely Case	$1,451,837,733	$39,792,657	$455,396	37.1
Worst Case	$1,438,573,514	$53,056,876	$455,396	27.9

Figure 21 - Option 6a Benefits, Costs and BCR run-out

5.4 Option 6b ('likely case' data for first 30 years shown)

Determine fitment increase by year due to Option 6b intervention.

Year		Vehicle Sales	Fitment at Sale via Option	BAU Fitment at Sale	Fitment Increase at Sale
1	2018	60,326	45,244.18	36,195.35	9,049
2	2019	63,342	63,278.51	43,072.46	20,206
3	2020	66,509	66,442.44	49,881.71	16,561
4	2021	69,834	69,764.56	56,565.86	13,199
5	2022	73,326	73,252.79	62,693.83	10,559
6	2023	76,992	76,915.43	68,523.25	8,392
7	2024	80,842	80,761.20	73,970.47	6,791
8	2025	84,884	84,799.26	78,517.83	6,281
9	2026	89,128	89,039.22	82,503.95	6,535
10	2027	93,585	93,491.18	86,692.38	6,799
11	2028	98,264	98,165.74	91,093.39	7,072
12	2029	103,177	103,074.03	95,717.77	7,356
13	2030	108,336	108,227.73	100,576.86	7,651
14	2031	113,753	113,639.12	105,682.56	7,957
15	2032	119,441	119,321.07	111,047.40	8,274
16	2033	121,829	120,611	113,350.66	7,260
17	2034	124,266	122,402	115,701.64	6,700
18	2035	126,751	124,216	118,101.31	6,115
19	2036	129,286	126,054	120,550.69	5,503
20	2037	131,872	127,916	123,050.81	4,865
21	2038	134,509	129,802	125,602.71	4,199
22	2039	137,200	131,712	128,207.47	3,504
23	2040	139,944	133,646	130,866.17	2,780
24	2041	142,742	135,605	133,579.95	2,025
25	2042	145,597	138,317	136,349.92	1,968
26	2043	148,509	141,084	139,177.26	1,907
27	2044	151,479	143,905	142,063.16	1,842
28	2045	154,509	146,784	145,008.82	1,775
29	2046	157,599	149,719	148,015.48	1,704
30	2047	160,751	152,714	151,084.41	1,629

Determine total crashes alleviated by year as fitted (due to intervention) motorcycles are bought and penetrate the fleet over time. Multiply crash likelihood for motorcycle's age by annual fitment increase each year, summating over motorcycles of all ages for each year).

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Vehicles
1	77																														77
2	181	171																													352
3	194	404	140																												738
4	196	432	331	112																											1071
5	292	438	354	264	90																										1438
6	130	653	359	283	211	71																									1706
7	75	290	535	286	226	168	58																								1637
8	58	168	238	426	229	180	136	53																							1487
9	54	130	137	189	341	182	145	126	55																						1361
10	51	122	107	109	152	271	147	134	131	58																					1281
11	85	114	100	85	88	120	219	136	140	136	60																				1283
12	80	190	94	79	68	70	97	203	142	146	141	62																			1372
13	111	179	156	75	64	54	56	90	211	147	151	147	65																		1506
14	107	249	147	124	60	50	44	52	94	220	153	157	153	67																	1677
15	100	238	204	117	99	47	41	41	54	98	228	159	164	159	70																1820
16	128	224	195	163	93	79	38	38	42	56	102	238	166	170	165	62															1959
17	79	286	183	156	130	74	64	35	39	44	59	106	247	172	177	145	57														2054
18	71	176	235	146	125	103	60	59	37	41	46	61	110	257	179	155	134	52													2046
19	53	158	144	187	117	99	84	56	61	38	43	47	63	114	267	157	143	122	47												2001
20	77	118	130	115	150	93	80	77	58	64	40	44	49	66	119	235	145	131	110	41											1941
21	89	173	96	103	92	119	75	74	81	60	66	42	46	51	69	104	216	132	118	97	36										1940
22	70	199	142	77	83	73	96	70	77	84	63	69	43	48	53	60	96	198	119	104	84	30									1937
23	73	157	163	113	61	66	59	89	72	80	87	65	72	45	50	47	56	88	178	105	90	70	24								1909
24	76	164	128	130	90	49	53	55	93	75	83	91	68	75	47	44	43	51	79	157	91	75	56	17							1888
25	50	169	134	102	104	72	39	49	57	96	78	87	94	70	78	41	40	39	46	70	136	76	60	41	17						1844
26	49	111	138	107	82	83	58	37	51	59	100	81	90	98	73	68	38	37	35	40	60	113	60	43	39	16					1769
27	37	109	91	110	86	65	67	54	38	53	62	104	85	94	102	64	63	35	33	31	35	50	90	44	42	38	16				1697
28	26	83	90	72	88	68	53	62	56	40	55	64	108	88	98	89	59	57	31	29	27	29	40	65	43	41	37	15			1614
29	27	58	68	71	58	70	55	49	64	58	41	58	67	113	92	86	83	54	52	27	25	23	23	29	64	41	39	35	14		1544
30	14	60	48	54	57	46	57	51	51	67	60	43	60	69	117	80	79	75	49	46	24	21	18	17	28	62	40	38	34	14	1478

Determine motorcyclist trauma alleviated by year

Year		Crashes alleviated	Fatal	Major	Minor
1	2018	77	0.85	12.42	11.99
2	2019	352	3.93	57.02	55.04
3	2020	738	8.23	119.48	115.33
4	2021	1071	11.94	173.44	167.41
5	2022	1438	16.02	232.73	224.64
6	2023	1706	19.01	276.14	266.54
7	2024	1637	18.24	265.01	255.79
8	2025	1487	16.57	240.73	232.37
9	2026	1361	15.16	220.24	212.59
10	2027	1281	14.28	207.41	200.20
11	2028	1283	14.30	207.70	200.48
12	2029	1372	15.29	222.07	214.35
13	2030	1506	16.79	243.83	235.36
14	2031	1677	18.69	271.43	261.99
15	2032	1820	20.28	294.59	284.35
16	2033	1959	21.83	317.09	306.07
17	2034	2054	22.89	332.42	320.87
18	2035	2046	22.80	331.22	319.71
19	2036	2001	22.30	323.96	312.70
20	2037	1941	21.63	314.22	303.30
21	2038	1940	21.62	314.01	303.09
22	2039	1937	21.58	313.47	302.57
23	2040	1909	21.27	309.01	298.27
24	2041	1888	21.04	305.60	294.98
25	2042	1844	20.55	298.55	288.17
26	2043	1769	19.71	286.32	276.37
27	2044	1697	18.91	274.71	265.16
28	2045	1614	17.99	261.24	252.16
29	2046	1544	17.20	249.90	241.21
30	2047	1478	16.47	239.30	230.98

Total lives saved over 35-year run-out period: 587.

Determine costs and savings over BAU by year

Year		Crashes alleviated	Trauma savings $	Fitment costs over BAU		Governme nt costs	Net $ (savings less costs)
1	2018	77	7,376,538	4,004,110	499,705	50,000	2,822,723
2	2019	352	33,872,787	8,941,178	466,391	50,000	24,415,219
3	2020	738	70,981,634	7,328,122	433,077	50,000	63,170,434
4	2021	1,071	103,038,240	5,840,425	399,764	50,000	96,748,052
5	2022	1,438	138,258,422	4,672,340	366,450	50,000	133,169,632
6	2023	1,706	164,050,839	3,713,537	333,136	50,000	159,954,166
7	2024	1,637	157,434,786	3,004,899	299,823	50,000	154,080,064
8	2025	1,487	143,014,888	2,779,531	266,509	50,000	139,918,848
9	2026	1,361	130,841,953	2,891,860	233,195	50,000	127,666,898
10	2027	1,281	123,218,338	3,008,472	199,882	50,000	119,959,984
11	2028	1,283	123,389,070	3,129,516	166,568	50,000	120,042,986
12	2029	1,372	131,925,241	3,255,143	133,255	50,000	128,486,844
13	2030	1,506	144,856,539	3,385,509	99,941	50,000	141,321,089
14	2031	1,677	161,249,139	3,520,774	66,627	50,000	157,611,737
15	2032	1,820	175,010,286	3,661,102	33,314	50,000	171,265,871
16	2033	1,959	188,379,125	-	-	-	188,379,125
17	2034	2,054	197,484,853	-	-	-	197,484,853
18	2035	2,046	196,773,114	-	-	-	196,773,114
19	2036	2,001	192,457,458	-	-	-	192,457,458
20	2037	1,941	186,673,634	-	-	-	186,673,634
21	2038	1,940	186,544,801	-	-	-	186,544,801
22	2039	1,937	186,224,020	-	-	-	186,224,020
23	2040	1,909	183,574,751	-	-	-	183,574,751
24	2041	1,888	181,549,893	-	-	-	181,549,893
25	2042	1,844	177,360,162	-	-	-	177,360,162
26	2043	1,769	170,095,895	-	-	-	170,095,895
27	2044	1,697	163,198,754	-	-	-	163,198,754
28	2045	1,614	155,199,355	-	-	-	155,199,355
29	2046	1,544	148,457,755	-	-	-	148,457,755
30	2047	1,478	142,162,235	-	-	-	142,162,235

Determine NPV benefits and costs and benefit-cost ratios (35-year runout period, best and worst case included for comparison)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio
Best Case	$1,633,038,339	$29,479,937	$455,396	55.6
Likely Case	$1,618,298,370	$44,219,905	$455,396	37.2
Worst Case	$1,603,558,402	$58,959,873	$455,396	28.0

Figure 22 - Option 6b Benefits, Costs and BCR run-out

Summary

Table 20 - Summary –Options 2a,2b,6a and 6b, 35-year run-out period

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Lives Saved	Major Avoided	Minor Avoided	Total Benefits	Total Costs
Option 2a: User information campaigns - targeted awareness (77% fitment effect, $3m campaign cost per year)									
Best Case	$371,705,566	$7,312,887	$14,299,619	18.20					
Likely Case	**$368,049,122**	**$10,969,330**	**$14,299,619**	**15.57**	**97**	**1,186**	**1,353**	**$393,318,071**	**$25,268,949**
Worst Case	$364,392,679	$14,625,773	$14,299,619	13.60					
Option 2b: User information campaigns - advertising (8% fitment increase on BAU, $9m campaign cost per year)									
Best Case	$378,671,629	$7,001,984	$81,971,226	5.26					
Likely Case	**$375,170,637**	**$10,502,976**	**$81,971,226**	**5.06**	**190**	**2,337**	**2,666**	**$467,644,838**	**$92,474,202**
Worst Case	$371,669,645	$14,003,968	$81,971,226	4.87					
Option 6a: Mandatory standards ABS>=125 (100% fitment effect)									
Best Case	$1,465,101,952	$26,528,438	$455,396	55.30					
Likely Case	**$1,451,837,733**	**$39,792,657**	**$455,396**	**37.07**	**534**	**7,753**	**7,484**	**$1,492,085,786**	**$40,248,053**
Worst Case	$1,438,573,514	$53,056,876	$455,396	27.88					
Option 6b: Mandatory standards ABS>125 & 50<CBS/ABS<125 (100% fitment effect)									
Best Case	$1,633,038,339	$29,479,937	$455,396	55.55					
Likely Case	**$1,618,298,370**	**$44,219,905**	**$455,396**	**37.22**	**587**	**8,521**	**8,225**	**$1,662,973,671**	**$44,675,301**
Worst Case	$1,603,558,402	$58,959,873	$455,396	27.99					

The Government's Regulatory Burden Measure (RBM) framework requires that regulatory costs imposed on business, the community and individuals due to new regulations (or changes to regulations) be quantified and measures that offset this cost impost must be identified. The preliminary RBM per year, calculated in accordance with the Government's RBM framework[25] for each option is: Option 2a $1,271,221; Option 2b $1,171,909; Option 6a $4,463,941; Option 6b $4,968,240. It is anticipated that regulatory savings such as harmonising ADRs with international standards can be used to offset RBM for the chosen option.

[25] Divide total costs to business, individuals and community organisations (but not governments) over ten years by 10

APPENDIX 4—SENSITIVITY ANALYSIS

A sensitivity analysis was undertaken on Options 2a, 2b, 6a and 6b. This was based on the discount rate; effectiveness; number of motorcycle models affected (increase over BAU) by intervention per year; per cent of fleet eligible for CBS and the fitment rate and cost; and sales growth. The net benefits from the options remained positive under all variations.

The cost of fitment, regulation and road trauma were not tested. These were provided in consultation with industry and/or established government sources and so were considered accurate.

Discount rate

The 'likely' case used a discount rate of 7 per cent for the benefit-cost analysis, as recommended by OBPR, resulting in a BCR of 37.22 for Option 6b. A discount rate of 3 per cent would lead to increased net benefits (resulting in a benefit-cost ratio of 53.29 for Option 6b) but is unlikely to be sustained over the period of analysis (35 years). The analysis showed that even with a high (conservative) discount rate of 10 per cent, the benefit-cost ratio remains substantially beneficial (resulting in a benefit-cost ratio of 30.08 for Option 6b).

Sensitivity analysis results are provided in Table 20 for a wide variation in discount rates of 3, 7, and 10 per cent for each of the considered options 2a, 2b, 6a and 6b. Variation in the discount rate does not affect the ranking of options, with all options demonstrating substantial benefit despite variation.

Table 21: Impacts of changes to the discount rate

Discount rate	Net benefit ($m)	BCR
Option 2a		
3% (low discount rate)	553	20.63
7% (likely discount rate)	368	15.57
10% (high discount rate)	285	11.51
Option 2b		
3%	786	7.49
7%	375	5.06
10%	233	4.01
Option 6a		
3%	2626	53.05
7%	1452	37.07
10%	1005	29.97
Option 6b		
3%	2927	53.29
7%	1618	37.22
10%	1120	30.08

Effectiveness

ABS and CBS effectiveness against trauma crashes parameters were varied between high, likely and low values as per Table 21. The net benefits and BCR remain substantial even if a significantly lower effectiveness is assumed.

Table 22: Variation in technology effectiveness

Effectiveness	Net benefit ($m)	BCR
Option 2a		
ABS 23%, CBS 16% (low effectiveness: -10%)	249	10.85
ABS 33%, CBS 26% (likely effectiveness)	368	15.57
ABS 43%, CBS 36% (high effectiveness: +10%)	487	20.28
Option 2b		
ABS 23%, CBS 16%	233	3.52
ABS 33%, CBS 26%	375	5.06
ABS 43%, CBS 36%	517	6.59
Option 6a		
ABS 23%, CBS 16%	1000	25.84
ABS 33%, CBS 26%	1452	37.07
ABS 43%, CBS 36%	1904	48.31
Option 6b		
ABS 23%, CBS 16%	1114	25.94
ABS 33%, CBS 26%	1618	37.22
ABS 43%, CBS 36%	2122	48.50

Number of models affected

The number of new motorcycle models per year beyond BAU. This parameter is used for system development costs which are not attributable to campaigns, where consumers are encouraged to choose existing (developed) systems. Departmental RVCS data show 45 new models were certified for supply in 2015.

Parameter variation yields insignificant effect on net benefits and BCR, as per Table 22.

Table 23: Variation in number models affected by intervention per year

Models affected	Net benefit ($m)	BCR
Option 6a		
36 models (low)	1452	37.44
45 models (likely)	1452	37.07
54 models (high)	1451	36.71
Option 6b		
36 ABS, 16 CBS models (low)	1619	37.79
45 ABS, 24 CBS models (likely)	1618	37.22
54 ABS, 32 CBS models (high)	1618	36.68

Per cent of fleet eligible for CBS

Variation in this parameter is analysed for Option 6b only. Under Option 6b, CBS or ABS would be required for the percentage of small motorcycles eligible to fit CBS rather than ABS. This provides a fitment cost reduction but also a reduction in effectiveness against trauma. It is conservatively assumed that all eligible motorcycles would be fitted with CBS rather than the more expensive ABS.

Table 24: Variation in percentage of fleet eligible to fit CBS under Option 6b

Percent fleet eligible for CBS	Net benefit ($m)	BCR
Option 6b		
2% fleet CBS eligible (low)	1632	37.16
5% fleet CBS eligible (likely)	1618	37.22
8% fleet CBS eligible (high)	1605	37.26

As shown in Table 23, the effect of variation in this parameter is not significant. With a low CBS eligibility percentage, the number of motorcycles fitted with advanced braking systems increases beyond Option 6a (because the fitted fleet now includes additional motorcycles - those with capacity 50 to 125cc). However, once the amount of additional CBS-fitted motorcycles increases further, the benefit cost ratio continues to increase but the net benefit decreases slightly due to add expense of fitment and the reduction in effectiveness against trauma of CBS compared with ABS.

Fitment cost

Variation of fitment cost (cost to fit ABS or CBS to a motorcycle) from the expected (likely) ranges was additionally analysed. Substantial increase or decrease in the fitment cost had an insignificant impact upon the net benefit, with the ranking of options according to net benefit remaining the same. The effects of variation are shown in Table 24. The ranking of options according to net benefit remains unchanged under variation.

Table 25: Fitment cost range sensitivity

Fitment cost	Net benefit ($m)	BCR
Option 2a		
ABS $500-1000, CBS $300-600 (high cost ranges)	361	12.09
ABS $300-600, CBS $200-400 (likely cost ranges)	368	15.57
ABS $200-400, CBS $150-300 (low cost ranges)	372	18.17
Option 2b		
high	368	4.70
likely	375	5.06
low	379	5.25
Option 6a		
high	1427	22.80
likely	1452	37.07
low	1464	53.96
Option 6b		
high	1591	23.08
likely	1618	37.22
low	1632	53.67

Sales growth forecast

The expected motorcycle sales growth of 5 per cent per annum was varied to establish the effect of an increase or decrease in forecast growth. Table 25 summarises the effect of this variation.

Table 26: Changes in forecast motorcycle sales growth

Sales	Net benefit ($m)	BCR
Option 2a		
8% growth (high)	428	16.85
5% growth (likely)	368	15.57
2% growth (low)	315	14.28
Option 2b		
8% growth (high)	550	6.75
5% growth (likely)	375	5.06
2% growth (low)	252	3.80
Option 6a		
8% growth (high)	1926	38.785
5% growth (likely)	1452	37.07
2% growth (low)	1107	35.50
Option 6b		
8% growth (high)	21.47	39.04
5% growth (likely)	1618	37.22
2% growth (low)	1234	35.53

Increasing the forecast motorcycle sales growth parameter increases net benefit, and improves the BCR for each option. This is because a rapid increase in the quantity of new motorcycles fitted with advanced braking systems infiltrates the fleet more rapidly. Variation does not change rankings of option outcomes, nor is there a significant effect in BCRs.

APPENDIX 5 —TECHNICAL LIAISON GROUP (TLG)

Organisation
Manufacturer Representatives
Australian Road Transport Suppliers Association
Commercial Vehicle Industry Association
Federal Chamber of Automotive Industries
Federation of Automotive Product Manufacturers
Truck Industry Council
Bus Industry Confederation
Consumer Representatives
Australian Automotive Aftermarket Association
Australian Automobile Association
Australian Trucking Association
Australian Motorcycle Council
Government Representatives
Department of Infrastructure and Regional Development, Australian Government
Department of Transport, Energy and Infrastructure, South Australia
Department of Transport and Main Roads, Queensland
Transport for NSW, Centre for Road Safety, New South Wales
VicRoads, Victoria
Department of Transport, Western Australia
Transport Regulation, Justice & Community Safety, Australian Capital Territory
Department of Infrastructure, Energy and Resources, Tasmania
Department of Lands and Planning, Northern Territory
National Heavy Vehicle Regulator
New Zealand Transport Agency
Inter Governmental Agency
National Transport Commission

APPENDIX 6 – AWARENESS CAMPAIGNS

Introduction

There are numerous examples of awareness advertising campaigns that have been successful. One particularly successful campaign was the Grim Reaper advertisements of 1987. In an attempt to educate the public about risk factors for HIV Aids; television and newspaper advertisements were run showing the Grim Reaper playing ten pin bowling with human pins. This campaign led to significant increases in HIV testing requests meaning that the campaign effectively reached the target market. Other awareness campaigns can be as successful if well designed, planned and positioned. Two examples are the recent Skin Cancer Awareness Campaign and the Liquids, Aerosols and Gels Awareness Campaign.

Analysis of Costings

Providing accurate costings is a difficult task. Each public awareness campaign will consist of different target markets, different objectives and different reaches to name a few common differences. In providing a minimum and maximum response two cases have been used; the maximum cost is developed from the Department of Health & Ageing's Skin Cancer Awareness Campaign. The minimum cost is developed from the Office of Transport Security's Liquids, Aerosols and Gels (LAGs) Awareness Campaign.

Maximum Cost

The "Protect yourself from skin cancer in five ways" campaign was developed in an effort to raise awareness of skin cancer amongst young people who often underestimate the dangers of skin cancer.

Research prior to the campaign found that young people were the most desirable target market as they had the highest incidence of burning and had an orientation toward tanning. This group is also highly influential in setting societal norms for outdoor behaviour. A mass marketed approach was deemed appropriate.

The Cancer Council support investment in raising awareness of skin cancer prevention as research shows that government investment in skin cancer prevention leads to a $5 benefit for every $1 spent.

Whilst it is not a direct measure of effectiveness, the National Sun Protection Survey would provide an indication as to the changed behaviours that may have arisen as a result of the advertising campaign. The research showed that there had been a 31 per cent fall in the number of adults reporting that they were sunburnt since the previous survey in 2004 suggesting that the campaign was to some extent effective.

The actual effectiveness of the campaign is yet to be publicly released.

The costs of this campaign were from three sources:

Creative Advertising Services (e.g. advertisement development)	$378,671
Media Buy (e.g. placement of advertisements)	$5,508,437
Evaluation Research (measuring the effectiveness of the campaign)	$211,424
Total	**$6,098,532**

Applicability to Motorcycle Advanced Braking Systems

Using a mass marketing approach can be regarded as an effective approach because it has the ability to reach a large number of people. However, this may not be the most efficient approach as the advertisements will be exposed to people that are not members of the target market. It should also be noted that political sensitivities can arise from large scale marketing campaigns and that there is likely to be a thorough analysis of the spending. As a result, it is imperative to demonstrate that the campaign is likely to be effective prior to launch and that there is a measure that can demonstrate this.

Minimum Cost

In August 2006, United Kingdom security services interrupted a terrorist operation that involved a plan to take concealed matter on board an international flight to subsequently build an explosive device. The operation led to the identification of a vulnerability with respect to the detection of liquid explosives.

As a result, the International Civil Aviation Organisation released security guidelines for screening Liquids, Aerosols & Gels (LAGS). As a result new measures were launched in Australia. To raise awareness of the changes the following awareness campaign was run over a period of four months:

- 14 million brochures were published in English, Japanese, Chinese, Korean & Malay and were distributed to airports, airlines, duty free outlets and travel agents
- 1200 Posters, 1700 counter top signs, 57000 pocket cards, 36 banners and 5000 information kits were prepared.
- Radio and television Interviews
- Items in news bulletins
- Advertising in major metropolitan and regional newspapers
- A website, hotline number and email address were established to provide travellers with a ready source of information.
- 5 million resealable plastic bags were distributed to international airports
- Training for 1900 airport security screeners and customer service staff was funded and facilitated by the department.

The campaign won the Public Relations Institute of Australia (ACT) 2007 Award for Excellence for a Government Sponsored Campaign having demonstrated a rapid rise in awareness. 77 per cent of travellers surveyed said they had heard of the new measures in general terms and 74 per cent of respondents claimed to be aware of the measures when prompted.

The costs of this campaign were from three sources:

Developmental Research (e.g. Understanding Public Awareness prior to the campaign)	$50,000
Media Buy (e.g. Placement of advertisements)	$1,002,619
Evaluation Research (Measuring the effectiveness of the campaign)	$40,000
Total	**$1,092,619**

Applicability to Motorcycle Advanced Braking Systems

This campaign had a very narrow target market; international travellers. As a result, the placement of the message for the most part was able to be specifically targeted to that market with minimum wastage through targeting airports and travel agents.

Should a motorcycle campaign be run, there would be a similar narrow target market; new motorcycle buyers. As a result, placement of similar marketing tools could be positioned in places where consumers search for information. Particular focus may be on motorcycle sales locations.

APPENDIX 7 – INFORMATION CAMPAIGNS

Advertising Campaigns

The following are real-world advertising campaigns that featured automotive technologies as a selling point, with a measured outcome:

A Mitsubishi Outlander advertising campaign was launched in February 2008. It focused solely on the fact that the car had "Active Stability Control as standard". Changes in sales were attributable directly to the campaign. There was an immediate effect with sales of the Mitsubishi Outlander increasing by 9.1 per cent for the month of February alone.

A Hyundai advertising campaign was launched in April 2008, offering free ESC on the Elantra 2.0 SX until the end of June. This was supplemented by television commercials launched in early May. The impact of this campaign was significant, with a 52.8 per cent increase in sales for this model over the period.

A 2008 Volkswagen Golf advertising campaign aimed to inform the market that the Golf had "extra features at no extra cost". The result was a 69.1 per cent increase in sales for those models over the April – June period.

APPENDIX 8 – PUBLIC COMMENT, EARLY ASSESMENT RIS

Comments submitted in confidence have not been tabled for publication but have been considered in analysing the options . Comment summaries have been developed by the Department of Infrastructure and Regional Development.

Correspondent	Comment summary	Departmental response
Transport for NSW	Broad support for Option 6b. Detailed comments were issued to the Department in confidence.	Noted. This is the recommended proposal.
VicRoads	1. Notes that the Victorian Government has strongly promoted the benefits of ABS for motorcycles and will continue to do so. 2. Supports the recommended option of ABS for motorcycles greater than 125 cc and ABS or CBS for motorcycles between 50 cc and 125 cc with the earliest implementation schedule possible. 3. Encourages the Commonwealth to additionally consider user information campaigns including targeted awareness and advertising. 4. Suggests additional research to assess benefit of extending mandatory fitment of ABS to off-road motorcycles. 5. Does not support switchable ABS where not aligned with UN Regulation No.78. Requests clarification around vehicle categorisation with regard to switchable ABS.	1. Noted. 2. Noted. This is the recommended proposal. 3. Noted. 4. This may be a future opportunity. 5. The draft ADR fully accommodates this comment.

Correspondent	Comment summary	Departmental response
MTA of SA	1. Contends that market forces should determine adoption rate of advanced motorcycle braking technologies. 2. Supports alignment with UN Regulation No. 78 including exemptions for certain classes of motorcycles. 3. Suggests an information and education campaign would also be required.	1. The RIS demonstrates that there is a strong case for regulation and this has been supported by most stakeholders. 2. The draft ADR fully accommodates this comment. 3. Noted.
NSW Sport and Recreation Group | Office of Sport	Considers the operation of ABS on motorcycles designed for off-road use.	The correspondent's concerns have been addressed via additional exemptions for motorcycles designed primarily for off-road use and via switches for dual purpose motorcycles.
Motorcycle Council of NSW	1. Contends that crash reduction estimates are likely overstated. 2. Suggests that additional education and training regarding ABS should be provided to riders.	1. The estimates are based on real-world Australian effectiveness values and so are considered highly accurate. Nonetheless, the sensitivity analysis in the RIS covers a wide variation in effectiveness in crash alleviation and shows that the net benefits in all cases are substantial. 2. It is expected that ABS training would become a more important part of license training as more systems are fitted.
Department of Transport WA	Supports the mandating of antilock and combined braking systems.	Noted. This is the recommended proposal.
Adelaide Brake Mechanical	Supports the mandating of advanced braking systems and advocates for better quality road surfaces.	Noted. This is the recommended proposal.

Correspondent	**Comment summary**	**Departmental response**
Triumph Designs Limited	Advises that Triumph has fitted ABS systems that are compliant with UN R78 (series/03) to all models following the EU mandating ABS for all motorcycles above 125 cc in 2014. Advocates for the specification of UN R78 incorporating the 03 and subsequent series of amendments in the ADR.	Agreed. This is reflected in the draft ADR.
Damien Owens, motorcycle instructor	Notes that the fitment of advanced braking systems does not remove responsibility from the rider to control the vehicle and contends that all riders should be required to undergo advanced rider training.	Noted. As mentioned above, it is expected that ABS training would become a more important part of license training as more systems are fitted.
Hunter Scooter	Contends that ABS should only be required on motorcycles with an engine capacity greater than 250 cc.	There would be a significant increase in net benefits (associated with novice riders in particular) if ABS was fitted to 125-250 cc capacity motorcycles as well as those greater than 250 cc.
SA Department of Planning, Transport and Infrastructure	1. Supports the recommended option of ABS for motorcycles greater than 125 cc and ABS or CBS for motorcycles between 50 cc and 125 cc with the earliest implementation schedule possible. 2. Suggests that further research into effectiveness of ABS on unsealed surfaces may be required. 3. Notes that DPTI carried out a campaign to improve rider awareness of the benefits of ABS.	1. Support for ABS disablement for use on unsealed and loose surfaces has been accommodated. 2. ABS switching for use on unsealed and loose surfaces has been accommodated in the draft ADR. 3. Noted.

Correspondent	Comment summary	Departmental response
FCAI	1. Recognises the benefits of ABS for motorcycles but not necessarily through regulation. 2. Requests ABS switching in line with EU requirements for dual-purpose motorcycles. 3. Requests exemptions for trail motorcycles. 4. Contends that implementation timing should allow industry adaptation to regulatory change.	1. The RIS demonstrates that there is a strong case for regulation and this has been supported by most stakeholders. 2. This has been accommodated in the draft ADR. 3. This has been accommodated in the draft ADR. 4. A compromise proposal on implementation timing has been recommended, following further discussion with industry and others.
NSW RMS	Supports the recommended option of ABS for motorcycles above 125 cc and ABS or CBS for motorcycles above 50 cc to 125 cc.	Noted. This is the recommended proposal.
Queensland TMR	Supports the recommended option of ABS for motorcycles greater than 125 cc and ABS or CBS for motorcycles between 50 cc and 125 cc with the earliest implementation schedule possible.	Noted. This is the recommended proposal.