Federal Chamber of Automotive Industries

Response to the ACCC's Final Recommendation to the Minister (made February 2019)

10 June 2019

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Introduction

The FCAI agrees with many of the recommendations in the ACCC's "Quad bike safety Final Recommendation to the Minister" (February 2019). However, two major areas of disagreement exist: (i) the requirement to fit OPDs to ATVs and (ii) the requirement that ATVs meet certain static stability criteria in order to be sold in Australia.

The recommendation to require OPDs on ATVs is without basis. The best evidence available is the DRI simulation analysis which concludes that OPDs will cause approximately as many injuries and deaths as they prevent. None of the coroners in the Queensland, New South Wales, or Tasmania multi-death inquests found the evidence supporting the fitment of OPDs to be persuasive, and, at most, their recommendations were that further studies be undertaken.

Since that time, the TARS Quad Bike User Surveys have been conducted, and the data from those surveys are in general agreement with the DRI simulation results. That is, the 'Main' survey data show that OPDs cause approximately as many injuries as they prevent. Notwithstanding the claims of the survey report's authors to the contrary, no conditions were found in which OPDs had any statistically significant benefits and, in the Fleet Managers survey, rollovers on ATVs with a Quadbar had a statistically significant higher risk of injury resulting in a hospital visit, compared to ATVs without an OPD. Rollovers on ATVs with *either* a Quadbar or a Lifeguard also had a higher risk of injury compared to ATVs without an OPD, but this result did not quite reach the 0.05 level of statistical significance. Therefore, the FCAI believes that rather than *requiring* OPDs, public safety demands that the ACCC should be asking the Minister to *prohibit* their fitment to ATVs.

The requirement that ATVs meet certain static stability criteria is also without basis. The only available epidemiological studies of ATV static stability did not find any statistically significant safety benefits associated with higher static stability. In fact, the Consumer Product Safety Commission (CPSC) found that higher static stability resulted in a non-statistically significant *increase* in the likelihood of injury. In the absence of compelling evidence, the FCAI does not agree with the establishment of criteria regarding minimum levels of static stability.

The FCAI will continue to advocate for a fair, impartial, and transparent real world study that compares injury outcomes with ATV characteristics. This will ensure that any vehicle measure that may be introduced into a standard has the necessary supporting evidence to show a positive safety outcome. This is unlike the premise underlying the ACCC recommendations, which is that vehicle characteristics with dubious and unknown safety benefits should be tested on farmers and other users.

As stipulated in the Australian Government 'Guide to Regulation' document, the ACCC must 'confirm the accuracy of the data on which their analysis is based', but it has failed to meet this basic requirement.

Without articulation of the evidence as to how the proposed measures will in fact improve safety, the ACCC's recommendations for OPDs and for lateral static stability requirements cannot be accepted.

Areas of General Agreement with the ACCC Recommendations

The major ATV brands and expert engineers have provided reliable data and evidence regarding the ACCC proposals raised in the Consultation RIS, and the FCAI is encouraged to see that the ACCC has accepted this advice and changed or removed many of the original proposals.

A. International standards

The FCAI agrees with the recommendation to require ATVs sold in Australia to meet the requirements of the US or the EN standard. Although most of the ATVs sold in Australia already meet one of these standards, the requirement would prevent substandard vehicles from being imported.

B. Additional rollover warning label

The FCAI accepts an additional warning label alerting the operator to the risk of rollover. It is important that riders understand the risks.

C. Five Star Safety Rating System

The FCAI agrees that a five star safety rating system would be desirable, provided that relevant evidence is available to inform the development of such a system. The FCAI also agrees that the system needs to consider additional factors such as cost and complexity in its development.

D. Providing static stability information to consumers

The FCAI would accept the testing and reporting to consumers of static stability on a hang tag, provided there is evidence to show that the proposed static stability values can be associated with improved safety. The difficulty with this is that there is no way to educate consumers regarding the relevance of this information, since that relevance is currently unknown. It is an open question as to what the association may be between static stability and safety (if one exists at all); there is currently no basis for a conclusion – or even an informed view - that higher static stability will provide any safety benefits at all.

E. Mechanical suspension

The FCAI agrees with the ACCC's decision not to recommend mechanical suspension requirements beyond what is already included in the US and EN standards. The FCAI agrees with the ACCC's decision not to recommend a requirement for a minimum wheel articulation of 150 mm.

F. Rear differentials

The FCAI agrees with the ACCC's recommendation not to include in any safety standard a requirement that ATVs have rear differentials.

G. Banning ATVs quad bikes

The FCAI agrees with the ACCC's recommendation that ATVs not be banned. The FCAI believes that the ways to reduce injuries and fatalities are well known and include requirements for wearing helmets, prohibiting passengers on single-seat ATVs, prohibiting children from riding adult ATVs, increasing riding training, and preventing drinking and riding.

Banning ATVs would be a tremendous disruption to many farms and businesses in Australia, since ATVs provide an entirely unique combination of utility and mobility that is of great value to their users.

H. Second hand ATVs

The FCAI agrees with the ACCC's decision to recommend that second hand ATVs not be required to meet any new safety standard.

I. Other vehicle types

The FCAI agrees with the ACCC's statement that there is general agreement that different vehicle types, such as SSVs, should have different star rating systems.

The FCAI recognises that the ACCC does not have the authority to regulate user behaviour, but it is nonetheless clear to all stakeholders that children should not be riding adult ATVs. Restricting the availability of youth models may result in more of this type of misuse, which is clearly undesirable. Although the quality of data collected on the type of ATV involved in incidents has been poor, it's the industry's understanding that no child fatalities have occurred on age-appropriate ATVs.

Areas of disagreement with the ACCC's Recommendations

A. OPDs

The FCAI strongly disagrees with the ACCC's recommendation that ATVs be fitted with OPDs. The available evidence overwhelmingly supports a conclusion that, rather than requiring OPDs on ATVs, the ACCC should prohibit them.

On the basis of its own selective consideration of various papers relating to OPDs, the ACCC claims - without disclosing its calculations – that; *"this information indicates more than a third of all quad bike fatalities may be prevented by the addition of OPDs designed to prevent operators from being crushed or pinned."* However, the ACCC provides no basis, no rationale, and no explanation for this proposition that *"more than a third"* of ATV deaths would be prevented by OPDs. Furthermore, it does not appear even to have considered how many deaths may be *caused* by OPDs. A fundamental principle of safety is 'First, do no harm'. It is extraordinary that the ACCC should propose mandating a supposed safety device without any regard to the potential for that device itself to cause injuries and deaths beyond a brief acknowledgement (page 71) that "in some situations after-market OPDs may contribute to injuries". The accompanying proposition, that "these [injuries] are usually minor", has no stated or known evidentiary basis.

The ACCC has failed to adhere to The Australian Government Guide to Regulation (page 30) "…to acknowledge the areas of uncertainty involved in its proposed measures…"; by not listing any of the caveats relating to the methodology it has used to determine a safety benefit. From page 30 of the Australian Government Guide to Regulation…

> *"Any areas of uncertainty must be weighed openly and honestly. Any assumptions you have made must be disclosed, discussed and assessed for their impact on the final decision… Were your assumptions validated? ... Caveats relating to methodology, estimates, limitations of your analytical techniques or issues of data quality must be disclosed and any potential for them to have affected your conclusions must be acknowledged and assessed.*
>
> *Good decision making relies on honest and thorough analysis.*

While it is unclear precisely what evidence the ACCC relied upon in making the recommendation for mandatory fitment of OPDs, it appears that it has accepted certain evidence but has rejected other, more compelling evidence. Below is listed the evidence that the ACCC appears to accept and the evidence the ACCC appears to reject, followed by a discussion of each of these points.

Evidence accepted and relied upon by the ACCC:

- The argument that since ROPS are beneficial on heavy tractors with seatbelts, they will also be beneficial on relatively lighter ATVs, which cannot accommodate seatbelts or any other rider restraints
- Testing by TARS, undertaken with a stationary ATV falling from an elevated platform onto a horizontal surface, is sufficiently representative of all potential ATV overturn fatal conditions
- Simulations by Dr. Richardson, undertaken with a highly deficient simulation model, using an ATV moving laterally (not forward) at the moment of overturn, and without an injury-monitoring crash dummy, provides useful information
- The portion of the TARS User Survey report considering anecdotal information obtained from a resort reporting OPD benefits is reliable, notwithstanding its obvious and extreme limitations and the known extensive confounding factors
- The TARS analysis of the “main” survey results involving a limited subset of that data, even though that analysis is based upon faulty statistics.
- The proposition that the TARS authors have used objective methods and provided unbiased review and thorough analysis of all data.
- Anecdotal reporting from one OPD proponent and one OPD manufacturer who have asserted that OPDs have had a safety benefit in Israel.

Evidence rejected or overlooked by the ACCC:

- Evidence obtained by the UK Health and Safety Executive, which rejected OPDs
- High quality simulation results from DRI, based on real-world overturn conditions with a validated model, which found that OPDs will cause as many injuries and fatalities as they may prevent
- The portion of the TARS “main” survey results, which shows that OPD-equipped ATVs had the same rate of serious injuries as non-OPD-equipped ATVs and which is consistent with the DRI simulation results
- The results of the TARS survey of Fleet Managers which showed that the Quadbar increased the likelihood of a hospital visit resulting from a rollover accident.
- The consequences of the finding that two thirds of crush and asphyxiation fatalities from a rollover without an OPD are when an ATV completes the roll on its side (TARS review of NCIS data). An OPD, by its very nature and design requirements, will mean more ATVs end up on their side in a rollover, which is the worst position for the crush and asphyxiation outcome.

Tractors

Regarding the issue of comparing ATVs to tractors, it should be noted that the requirement for tractors to have ROPS applies only to tractors which weigh **more than 560 kg**. This is because there is no known safety benefit for ROPS on tractors below that weight. As noted by Coroner Cooper in his findings in the Tasmania inquest (Ref 1):

> *"The evidence does not support treating quad bikes in the same way as tractors, given the many differences between the two types of vehicle. The Director (TAS WorkSafe) acknowledged this in his evidence to the inquest. In addition, it is observed that regulation 216 (3)(b) of the Work Health and Safety Regulations 2012 provides that the regulation does not apply to a tractor with a mass of less than 560 kilograms. I note the evidence was that few, if any, quad bikes exceed 560 kilograms in weight. Any comparison of quad bikes to tractors is erroneous and not supported by the evidence."*

Tractors that have ROPS also have seatbelts. However, seatbelts and other restraints are not feasible on ATVs because ATVs are rider active vehicles. The conclusion that can be drawn from this is that the evidence for the benefits of ROPS on heavy tractors with seatbelts does not translate to much lighter ATVs, without seatbelts.

TARS tilt table drop tests

The TARS testing of a stationary ATV falling 1.5 m onto a flat, horizontal surface from a table titled at up to 50 degrees does not offer much insight into how OPDs perform in real world accidents. It is not disputed by any of the engineers that, in certain overturn conditions, OPDs can protect the rider. It is also not disputed by them that, in other overturn conditions, OPDs will not protect the rider but will instead cause injury or death. What this means is that the full spectrum of real-world overturn conditions needs to be evaluated in order to judge the safety and the efficacy of OPDs.

This "full spectrum" of overturn conditions has been evaluated in two ways. First, DRI's simulations, which involved a sample of real-world ATV accident conditions obtained from the UK and US, have found that the Quadbar (as well as a variety of other OPDs and ROPS designs) will cause about as many deaths and injuries as it may prevent. Second, data from the TARS "main" survey similarly show that OPDs cause as many serious injuries as they prevent. Data from the TARS "Fleet Managers" survey show that riders of ATVs fitted with a Quadbar have a statistically significant higher rate of injury resulting in a hospital visit when an ATV rolls over in comparison to riders of ATVs not fitted with an OPD, and they indicate that riders of ATVs fitted with either a

Quadbar or a Lifeguard had more severe injuries than riders of ATVs not fitted with an OPD, although this result does not quite reach the 0.05 level of statistical significance.

Richardson simulations

The ACCC seems to accept evidence regarding 'simulations' provided by Dr. Richardson. But those simulations were performed with very primitive computer models that did not include vehicle suspension travel, rotating wheels, or steered handlebars or wheels; were not validated; included an unrealistic "rag doll" manikin model without joint rotation limits or stiffness; did not include monitoring for rider injuries; and involved mainly unrealistic and atypical vehicle motions (vehicle was sliding laterally down a slope while pointed across the slope). The model was unable to be validated against the physical world because, in his endeavours to do so, Dr Richardson was obliged to manipulate various aspects of the ATV's dimensions to incorrect values on a case by case basis so that he could achieve the desired simulation outcomes in the various cases.

In the Queensland coronial inquest, counsel assisting the coroner observed that (Ref 2):

> *The majority of limitations highlighted by DRI were accepted by Dr Richardson within his written report and when he provided oral evidence at the inquest. In my submission, Dr Richardson's report is limited, so limited weight should be placed on his findings.*

The FCAI agrees with this statement, and the ACCC also should not have placed any reliance at all on Dr Richardson's 'simulations'.

TARS OPD workplace safety survey

The TARS survey report regarding OPDs included a study where one resort, which offers ATV riding as a recreational opportunity for its guests, reported that injuries to its guests were greatly reduced after the fitment of Quadbars to its ATVs. However, what is not included in the TARS report is any listing of the many other changes that were also made at the resort in the same timeframe to seek to improve ATV safety, as listed in Table 1. This means that only the combined effect of these changes could be known, and it is not possible to know which of these changes on their own either improved safety, had no effect, or were indeed harmful. The TARS authors have chosen the years 2014-2016 as the post-OPD measuring period, however the introduction of OPDs was but one of nine safety measures introduced from 2008 onwards, yet they attribute OPDs as being the sole reason for improved outcomes. TARS did not explain why they chose the time period of 2014-2016 to evaluate the benefits of OPDs, instead of beginning in 2008 when the OPDs were installed.

This view is supported by the manager of the resort, who indicates that the safety improvements were in fact due to a number of measures introduced on the quad bike rides:

"In our experience, CPD fitment alone is not successful in reducing incidents on quads. The reason we introduced CPD's in about 2008, was to try and find solutions to our unique roll over's at low and almost no forward speeds causing injury when quads rolled on steep corner berms.

Around the same time as Tangalooma fitted CPD's to our tour operation quad bikes, we also introduced many other safety measures and procedures, consequently our incident rates and severity of injuries dramatically improved. It soon became apparent however that our use of quads is almost unique and that fitting CPD's had limited effect on actually reducing accidents or incidents by participants on our quad bike tours

Through providing what we deem as appropriate information and training at all levels from Management, tour guide and participant training, inductions and testing, we have now been able to eliminate about 80% of our incidents in the first place and due to these compulsory processes, we now rarely have serious accidents / incidents or injuries on tour." (personal communication from Tangalooma Resort Manager).

The FCAI believes that there is cause to question whether the TARS authors have reviewed data objectively, and without preconception as to what those data will show, or whether instead they had a predetermined view and sought to identify and present data which are supportive of that view. Combining all of the resort safety measures together, but claiming that the OPDs alone were responsible for safety improvements, is but one example of their apparent lack of independent and objective research methods and conclusions.

Figure 1 illustrates the unusual nature of a typical rollover at the resort. The terrain is groomed into trails with berms along the side. When the ATV slows or stops it can fall to the inside of the corner due to steep banking of the trail, and the OPD can come to rest on the inside sand bank.

Figure 1. Observation of typical low speed roll over with OPD resting on sand bank

Table 1. List of Safety Measures by the Resort in the TARS Survey

Safety Measure	Date Introduced	Incidents Reduced	Injuries Reduced
Vehicle selection	Introduced 1995 Smaller ATVs, low speed	Yes Yes	Yes Yes
Use of graded routes depending on group	1995 trialed Ongoing measure	Yes	Yes
Staff training	1997 manual 2000 probation period	Yes	Yes
Tourist helmets	1998	No	Yes
Grooming Tracks Recessed Tracks	1998 2000	Yes Yes	Yes Yes
Training Video	2001 Ongoing improvements	Yes	Yes
Speed Limits	Initially: <35 kph 2005: 10-20 kph	Yes	Yes
Graded tracks for different groups	2007	Yes	Yes
Speed Limits	2008: only 1st & 2nd gears to reduce speeds	Yes Yes	Yes Yes
Colour coded booking forms	2008 ID tourists with language issues	Yes	Yes
Crush Protection Device	2008	No	Yes for secondary injuries; not light injuries
Tourist must demonstrate skills before ride	2007 2012 further tests required (8 turns)	Yes, as poor riders don't get to ride solo	Yes Yes
Tool Box Talk	2012 daily review of incident or near miss	Yes	Yes
Guide numbers	Always: 5:1 guide 2013: increased with backup for groups >20	Yes	Yes
Monthly Review	2015	Yes	Yes
Vehicle Maintenance	Always More attention recently	Yes Yes	Yes Yes
Remove cheap repeat ride prices	2016	Yes stops repeats going faster	Yes
Staff helmets	2017 compulsory	No	Yes
Staff Training	2017 New Training Video	Yes	Yes

The ACCC appears to accept the TARS analysis of a subset of the "main" survey data in which the TARS authors assert that the Quadbar and the Lifeguard each appear to reduce chest injury severity in cases where the ATV rolled over the rider. However, it has previously been pointed out to the ACCC that the statistical analysis used by TARS as the basis for this assertion is not valid and that, in fact, the data really show no statistically significant difference between the ATVs that had no OPD and the ATVs that had a Quadbar or Lifeguard OPD.

It may be that the ACCC did not have the resources to enable it to evaluate properly the TARS statistical methods; any such evaluation would require an understanding both of the Goodman Kruskal gamma test that *was* employed by TARS and also the alternatives which *could have* been used, such as Pearson's chi squared and Fisher's Exact tests.

A more detailed discussion of this can be found in Annex 1. To summarise, the problem with using the Goodman Kruskal gamma test is that, like the chi squared test, it is an approximate test that is not valid if the values in any of the cells is "small". For the chi squared test, the recommendation is that each cell have a value of at least 5 in order for that test to be used. Because the Goodman Kruskal gamma test has not been as widely studied, no published recommendations are known to be available. However, as shown in Figure 2 in Annex 1, it appears that each cell would need to have a value of at least 10 (and probably more, since the p-values are still overstated at this point on the x-axis) in order to have confidence in the test. Because Table 8 from the TARS survey report has several cells with numbers much smaller than 10, the test is giving a p-value that is unrealistically low.

For tables with small counts in one or more cells, The Fisher-Freeman-Halton (FFH) Exact test is commonly used. For Table 8 from the TARS survey report, the FFH Exact test yields a p-value of 0.466, which is highly non-statistically significant. This means that it cannot be said that there is a difference between these data for ATVs with the Quadbar/Lifeguard as compared to ATVs with no OPD. An independent review by Pegasus Economics of the DRI review of the TARS analysis can be found in Annex 2. Pegasus found that

> *"According to Professor Graeme Ruxton of the University of Glasgow and Professor Markus Neuhäuser of the Koblenz University of Applied Sciences (2010, p. 1508), the FFH Exact test is the most appropriate exact test for contingency tables larger than 2x2 and provides good control over type I errors."*

Pegasus agrees that TARS should have established independence between the "Quadbar or Lifeguard" and "No OPD" groups before using the Goodman Kruskal test.

> *"The only criticism that we can level against the DRI review is its use of the Pearson chi-square test for independence in relation to Table 8 from the Quad Bike Workplace Safety Survey Report given the small number of observations in some of the cells. However, this shortcoming is overcome through its use of the FFH Exact test. On this basis, we concur with the overall findings from the DRI review. In particular, we strongly agree with the conclusion*

reached by DRI that the TARS Research Centre should have established independence before running the Goodman and Kruskal gamma test."

Pegasus concludes that:

"In the opinion of this author, the disclaimers provided by the TARS Research Centre are nowhere near adequate enough to reflect the overall poor quality of statistical analysis that it undertook."

Further, although the data in Table 8 from the TARS survey do not contain statistically significant differences, it is also important to look at the bigger picture. In other words, even if there is some body region in some subset of all crashes that may be protected by an OPD, if, overall, the OPD does not improve safety, it is not a valid safety device. In that regard, Table 2 below contains the data for all crashes and all OPDs from Table 4 of the TARS survey. This shows that ATVs fitted with an OPD had a slightly higher rate of serious injury in crashes than ATVs without an OPD, although this result is not statistically significant. This is consistent with other research from MIRA and DRI that has found that OPDs cause approximately as many injuries and fatalities as they prevent.

Table 2. Summary of the "main" TARS survey results (from Table 6 of the TARS survey

OPD	Crashes	Any Injury	Serious Injury (hospitalizations)	Any Injury as % of crashes	Serious Injury as % of crashes
No	1,307	264	68	20.20%	5.20%
Yes	122	22	7	18.03%	5.74%
			Ratio (No OPD/OPD):	1.12	0.91

The TARS Fleet Managers survey results indicate that the Quadbar is associated with a statistically significant increase in the risk of serious injury (defined as "attended hospital" or "admitted to hospital"). The data for the Quadbar from the Fleet Managers survey are shown in Table 3. The p-value for Fisher's Exact test for this table is p = 0.010, which means that the result is statistically significant.

Table 3. Fleet Managers survey results for the Quadbar compared to no OPD (data from Table 2 of the TARS survey report)

OPD	“No injury” or “Minor injury”	“Attended hospital” or “Admitted to hospital”	Percentage of rollover crashes resulting in “Attended hospital” or “Admitted to hospital”
None	45	12	21.1%
Quadbar	3	6	66.7%

p-value = 0.01 (Fisher’s Exact test)
p-value = 0.004 (chi squared test, note that the minimum expected cell count is 2.5, so this test should not be relied upon)

The TARS Fleet Managers survey results for the Quadbar and Lifeguard compared to no OPD are shown in Table 4. Fisher’s Exact test for this table yields a p-value of 0.055, which does not quite reach the commonly accepted 0.05 level of statistical significance.

Table 4. Fleet Managers survey results for the Quadbar and Lifeguard compared to no OPD (data from Table 2 of the TARS survey report)

OPD	“No injury” or “Minor injury”	“Attended hospital” or “Admitted to hospital”	Percentage of rollover crashes resulting in “Attended hospital” or “Admitted to hospital”
None	45	12	21.1%
Quadbar and Lifeguard	5	6	54.5%

p-value = 0.055 (Fisher’s Exact test)
p-value = 0.021 (chi squared test, note that the minimum expected cell count is 2.9, so this test should not be relied upon)

Analysis of fatalities

Proponents of OPDs have claimed that there have been no fatalities caused by an OPD in Australia and that this is evidence that OPDs are reducing fatalities. However, there have actually been at least two fatalities on ATVs fitted with OPDs, and it cannot be definitively determined whether or not either fatality would have been prevented if there had not been an OPD. However, in the Tasmania fatality, the OPD, which was similar in size, function and position to the U-Bar that has previously been evaluated by MIRA and DRI, appears to have prevented the rider from pushing the ATV off of his shoulder after it came to rest on him. He was eventually asphyxiated after trying to escape from under the side of the ATV. Testimony accepted by the Tasmania coroner also considered that the OPD may have limited the separation of rider and ATV, which was critical in this incident.

From a statistical viewpoint, the number of known fatalities on OPD-equipped ATVs is consistent with what would be expected on the same number of ATVs not equipped with OPDs, as shown in the analysis in Table 5. This analysis includes a breakdown for each year since 2008 in Australia, given the number of ATVs in use, the number of OPDs in use, and the number of fatalities that actually occurred, how many of those fatalities would be expected on OPD-equipped ATVs (row E).

The sum of these since 2008 comes to 2.20 fatalities, which is nearly identical to the number of fatalities that are known to have in fact occurred. It should be noted that the “Number of ATVs in Australia” in Table 5 includes only those sold by FCAI member companies and Polaris. ATVs sold by other manufacturers would add at least 10% to these figures, which would reduce the “Total predicted fatalities”. Although the predicted and actual numbers of fatalities are far too small to show statistically significant differences, these data certainly do not support an argument that OPDs are reducing fatalities.

Table 5. Analysis of the expected number of fatalities in Australia on ATVs fitted with OPDs since 2008

		Year										
Row	Variable	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
A	[1]Number of ATVs in use in Australia	173,684	181,955	188,004	196,375	204,875	208,393	211,483	213,607	216,016	216,046	214,063
B	[2]Number of CPDs in use in Australia	100	200	400	1,138	1,807	2,432	2,905	3,532	5,688	7,844	10,000
C	Percentage of ATVs in Australia with CPDs (Row B/Row A)	0.1%	0.1%	0.2%	0.6%	0.9%	1.2%	1.4%	1.7%	2.6%	3.6%	4.7%
D	[3]Number of ATV fatalities in Australia	12	17	6	20	19	21	15	21	10	11	9
E	[4]Expected number of fatalities on ATVs with CPDs, if CPD had no effect	0.01	0.02	0.01	0.12	0.17	0.25	0.21	0.35	0.26	0.40	0.42

[1]Data is based on Australian ATV sales, assuming a 6.5% attrition rate per year.

[2]2010 - 2015 data is from Lambert "Quad bike sales and estimates of the number of quad bikes in use and fatalities and fatality rates", 2008-2009 data is extrapolated. However, note that the total CPD-years is 27,899, which is substantially more than the value reported in Lambert September 2016 paper (16,183). 2016 - 2018 data is interpolated from the number in use in 2015 to 10,000 in use in 2018.

[3]2011 - 2015 data is from Safe WorkAustralia QuadWatch website, 2008 - 2010 data is from Lower, et al, "Quad bike deaths in Australia, 2001 - 2010"

[4]Row C multiplied by Row D.

G	Total predicted fatalities on ATVs with CPDs from 2008 - 2018 (sum of Row E):	**2.20**
H	Actual fatalities on ATVs with CPDs from 2008 - 2018:	**2**

Predicted fatalities are nearly identical to the actual fatalities (not statistically significant)

DRI simulations

The DRI simulations, which have been extensively validated, appear to have been largely ignored by the ACCC. The ACCC can refer to the previous reports for a more complete discussion of this topic, but the simulation results comparing the Quadbar to a baseline ATV (both helmeted) as well as the results comparing a rider with a full-face helmet to an unhelmeted rider (both without an OPD) are summarized in Table 6.

Table 6. Summary of DRI simulation Risk/Benefit and Net Benefit results

Baseline	Counter-measure	Injury Index	Estimated Risk/Benefit Percentage	Estimated Net Benefit Percentage	Statistical Significance
No CPD Full face helmet	**CPD** Full face helmet	ICnorm	108% (69%, 168%)	-3% (-24%, 18%)	**Not Significant** p=0.760
		Prob. of Fatality	121% (72%, 198%)	-10% (-41%, 21%)	**Not Significant** p=0.512
No helmet No CPD	**Full face helmet** No CPD	ICnorm	**9% (6%, 21%)**	**60% (45%, 75%)**	**Significant p<0.001**
		Prob. of Fatality	**6% (4%, 22%)**	**72% (53%, 92%)**	**Significant p<0.001**

Color Key	
(green)	Estimated risk/benefit percentage is significantly less than 100% (p-value less than or equal to 0.05 and the injury risks of the device are much less than the injury benefits of the device), and the estimated net benefit is significantly greater than 0% (i.e., significant benefit exists). May be a reasonable device assuming acceptable functional characteristics.
(pink)	Estimated risk/benefit percentage significantly more than 100%) p-value less than or equal to 0.05 and the injury risks of the device are greater than injury benefits of the device), and the estimated net benefit significantly less than 0% (i.e., significant disbenefit exists). Device causes significantly more injuries than it prevents.
(white)	Estimated risk/benefit percentage not significantly different from 100% (p-value is greater than 0.05, the injury risks of the device are effectively equal to injury benefits of the device), and the estimated net benefit percentage not significantly different from 0% (within 95% confidence interval). Injury risks of the device are effectively equal to injury benefits of the device.

It is disappointing that, beginning on page 59 of the ACCC Final Recommendation to the Minister, the ACCC has chosen to simply regurgitate the criticisms made by OPD proponents rather than reviewing the evidence independently and giving consideration to the comments made by FCAI which address these criticisms. As an example, the ACCC claims that in "*105 of the 113 cases the actual part of the body injured was not injured in the simulation*" (page 60). This is absolutely irrelevant, since DRI was not simulating these 113 (actually 110) cases and was certainly not attempting to *recreate* them. Rather, DRI was simulating the conditions of the respective overturns (speeds, slopes, angles, bumps, etc.). DRI was not simulating the actual ATV involved in the accident or the actual human rider, whose height, weight, injury tolerance, etc. were generally unknown. Because of those differences, the injury outcomes of the overturns would be expected to be very different. While it may not be surprising that those with a vested interest in discounting the DRI research prefer to ignore the explanations of this methodology that have been provided to them over many years and through various inquests and other forums, it is disappointing that the ACCC has chosen to accept the false proposition that DRI was recreating the actual cases, rather than simply simulating the overturn conditions, and has relied upon this error to brush aside DRI's highly sophisticated research and its conclusions regarding CPDs.

The ACCC, on page 60, discusses the few criticisms that Associate Professor Anderson made of the DRI simulations, but in doing so completely misrepresents his opinions regarding the DRI analysis, which were generally supportive. The ACCC has also omitted Associate Professor Anderson's conclusions. He said in his report that "*I am of the opinion that the main conclusions reached in the [DRI] report are generally sound insofar that the simulations failed to show that the Quad Bar was an effective way to reduce injury risk in the simulation cases.*"

The Troutbeck and Associates report dismisses the DRI simulations and says "*The use of simulations to further explore the safety outcomes of CPDs has been extensive. But, in the opinion of the author, the simulation studies have failed to fully document the necessary validation process that would give a reader confidence that there is a simulation model that can reflect the potential for harm and provide reasonably accurate predictions of the outcomes.*" This is a surprising statement since it could have been made only if the author had not reviewed, or had not reviewed in sufficient detail, the DRI validation report ("ATV ROPS/CPD Tests and Simulations", Van Auken, et al., 1998), despite that report being listed as a reference in the Troutbeck and Associates report. The Van Auken, et al. report provides extensive documentation on the validation process and provides extensive data and information regarding the level of agreement between the 12 full-scale calibration tests that were undertaken and the simulations of those tests.

With respect to that validation of the DRI simulations, Professor Anderson, in his independent review of the DRI work, said:

"The model has been validated against full scale tests to a reasonable extent, based mainly on the kinematics of the ATV and rider in a rollover. The MATD and ATV model have been subjected to many calibration tests to measure the stiffness of its components and these are documented in the DRI reports. I am generally satisfied with the level of validation applied to the models."

Whatever criticisms may be made of the DRI simulations by the manufacturers and other proponents of OPDs, they cannot ignore that the DRI simulations lead to the same conclusions as the TARS "main" survey of real-world accidents:

- The TARS "main" survey results indicate a statistically non-significant increase in serious injuries for OPDs
- The DRI simulations with a helmeted rider indicate a statistically non-significant increase in injuries and probability of fatality for the Quadbar

In fact, the DRI simulations may be underpredicting the harm caused by OPDs:

- The TARS Fleet Managers survey results indicate a ***statistically significant increase in hospital visits in crashes involving a ATV with a Quadbar compared to an ATV without an OPD***
- The TARS Fleet Managers survey results indicate an ***increase in injury severity associated with a Quadbar or Lifeguard equipped ATV compared to an ATV without an OPD***, although this result did not quite reach the 0.05 level of statistical significance

The conclusion, both from the DRI simulations and from the TARS surveys, is that OPDs should not be fitted to ATVs and should be prohibited from being marketed as safety devices.

Effect on the market

It is unclear how a requirement to fit an OPD would be implemented in the Australian ATV market. It is not certain at present, but it seems highly unlikely that any FCAI member would fit OPDs to their vehicles; already three of the major ATV brands have indicated they will cease to supply ATVs to the Australian market rather than designing and/or fitting OPDs. This is primarily a safety and ethical decision in consideration of users, having regard to the matters discussed above, but also due in part to the high costs of re-engineering a vehicle for OPDs (since the structure of current ATVs cannot withstand the high forces that would be transmitted through the OPD), the relatively low volume of ATVs sold in Australia, and the extremely low likelihood of being able to develop an OPD that will have acceptable safety risks (since no one over the last 30 years has been able to do so).

The likely outcome is that the entirety of the Australian ATV market may be serviced by non-FCAI companies, and that OPDs will be fitted as aftermarket devices on informally imported vehicles of arguably lower quality. If FCAI member companies are excluded from the Australian market, there will be substantial economic impacts for regional businesses, and for agricultural productivity, without any improvement on safety outcomes.

B. Static stability requirements

The FCAI disagrees with the ACCC's requirements for minimum static stability. As the ACCC is aware, there is no direct evidence that higher static stability improves safety outcomes.

Superficially, it would seem obvious that higher static stability is desirable. However, this assumes that:

- Riders will ride the more statically stable ATVs in the same way as less statically stable ATVs. In other words, they won't attempt to traverse steeper hills, ride at higher speeds, or otherwise make use of the increased stability margin.
- The design changes required to make ATVs more statically stable won't increase the likelihood of crashing. This could happen, for example, because, with a wider track width, impacts to one wheel will impart a greater yaw moment to the vehicle. A wider track width would also reduce the clearance between the ATV and obstacles, such as trees or rocks, along the path of travel.
- The injury outcomes of overturns with a more statically stable ATV will not be worse than the outcomes with a less statically stable ATV. In other words, if the design changes required to make a vehicle more statically stable result in more severe injuries, the net outcome might be an increase in overall injury with the more statically stable vehicles. This could happen, for example, if the more statically stable vehicles are ridden at higher speeds, resulting in higher injury severity, or if wider ATVs are more likely to pin a rider because their ability to roll away from the rider is reduced.

As the ACCC is aware, for ATVs, the US CPSC did not find a safety improvement associated with higher static stability. In fact, it found that ATVs that were more statically stable were associated with higher rates of injury, although this result was not statistically significant. Proponents of increased static stability claim that this was due to the relatively limited range of static stability in ATVs at the time of that study. The Kst (a measure of static stability) of the most statically stable ATVs in the CPSC study were about 25% higher than the Kst of the least statically stable ones.

However, in the measurements of eight ATVs in the TARS Quad Bike Performance Project, the TTR of the most statically stable ATV was about 69% higher than the TTR of the least statically stable one. This means that even among this relatively small sample of ATVs, there is a much greater range of static stability. This also means that a study using the CPSC methodology would be much more likely to provide statistically significant results.

The effects of the proposed static stability limits on the Australian ATV market would be severe. A large proportion of the models currently available would no longer be available. It is likely that the remaining models would have less ground clearance and therefore less mobility than the models forced out of the market. In any case, consumer choice would be substantially reduced.

Because a) there is no evidence that higher static stability will result in safety improvements, b) it is possible for such evidence to be gathered by the ACCC, and c) severe market disruptions would result from these static stability requirements, the FCAI recommends that any requirement for minimum static stability be postponed until that evidence has been gathered in order to take the guesswork out of this proposal.

Conclusions

ATV safety must remain a high priority for all stakeholders. Unless and until evidence-based engineering solutions are developed which will enhance safety – but even then - the emphasis must be on changing the ATV culture in Australia such that riders wear helmets, don't carry passengers on single-seat ATVs, and don't allow children to ride adult ATVs. These measures alone could reduce deaths by over 50%.

The evidence regarding the lack of benefit of OPDs is clearer than ever. We now know that real-world injury and fatality outcomes are in agreement with the DRI simulation results and that OPDs cause approximately as many injuries as they prevent. In the Fleet Managers survey, the Quadbar was found to be harmful, and the result was statistically significant. Therefore, rather than *requiring* OPDs, the ACCC should be *prohibiting* their fitment to ATVs.

The evidence regarding the safety effects for ATVs of higher static stability is less clear. Intuition might lead one to believe that higher static stability would offer safety benefits, but the epidemiological data do not bear this out. There is no evidence that increased ATV static stability improves safety, and no evidence that would inform manufacturers or regulators as to the levels of static stability that are desirable. It is known that requirements to increase static stability will result in ATVs that have reduced mobility because of increased track width/wheelbase or reduced centre of gravity height, which would reduce ground clearance and breakover angles. The FCAI can accept the testing and reporting of static stability levels, but no related safety advice should be provided to consumers until evidence becomes available to establish an association between static stability and safety.

The Minister responsible for reviewing the ACCC Final Recommendations should be very concerned about the lack of supporting evidence and independent reasoning behind the OPD and lateral stability proposals.

The Minister should also question why the ACCC is putting forward these recommendations notwithstanding its inability to offer a reasoned and evidence-based calculation of how many people the proposed measures will save, and how many injuries will be reduced.

The FCAI has been encouraging Australian safety agencies to establish the relationship between particular vehicle characteristics and injury outcomes, but to no avail. Without this evidence on beneficial and harmful characteristics, the ACCC is really proposing measures that may have unintended consequences, and, by doing so, it is experimenting with farmers' lives.

References

1. Cooper, S., "FINDINGS, RECOMMENDATIONS and COMMENTS of Coroner Simon Cooper following the holding of an inquest under the Coroners Act 1995 into the quad bike related deaths of: Heather Dawn Richardson, Jan Severin Jensen, Kendall Russell Bonney, Vicki Mavis Percy, Jay Randall Forsyth, Jacob Graham Green and Roger Maxwell Larner," Tasmania, 2017.
2. De Waard, P., "Submissions of Counsel Assisting (Peter De Waard)," Phase 2 – Coronial recommendations re quad bike related deaths, Queensland, 2015.

Annex 1

Discussion of the Goodman Kruskal gamma test

As opposed to exact tests, both the Goodman Kruskal gamma test and chi squared test rely upon approximations or the asymptotic standard error (ASE) assumption. What this means is that these tests converge to the correct answer as the number of samples approaches infinity, but that they have unacceptable error when the number of samples is "small". How small is "small" is the key question.

One way to define "small" is to consider the "minimum expected cell count" in the data, which is based on the row and column totals. Table 7 shows the data from the TARS survey along with the "expected" cell counts under the null hypothesis (that there is no difference between the two rows). The minimum expected cell count is commonly used to quantify the appropriateness and validity of a statistical test.

Table 7. Data from the TARS Survey (Table 8) along with the expected cell counts based on the row and column totals

Quadbar or Lifeguard OPD?	Injury Severity			Column Totals
	No	Non-Hospital	Hospital	
No	182 (expected 184.4)	23 (expected 22.1)	20 (expected 18.4)	225
Yes	18 (expected 15.6)	1 (expected 1.9)	0 (expected 1.6)	19
Row Totals	200	24	20	224

Since the chi squared test is much more commonly used than the Goodman Kruskal gamma test, more extensive guidelines for its use exist. Many researchers recommend that the minimum expected cell count be greater than or equal to 5 for the chi squared test to be used. Statistical software packages such as SPSS also report in their results when this guideline is not satisfied. Similar published guidelines for the Goodman Kruskal gamma test are not known to exist.

DRI has run Monte-Carlo simulations of both the chi squared and Goodman Kruskal gamma tests to evaluate the reliability of the resulting p-values with a range of minimum expected cell counts. The results shown in Figure 2 depict the p-values for randomly generated contingency tables that satisfy the null hypothesis for the test (i.e., the row and column variables are independent) versus the minimum expected cell count for the contingency table. Figure 1 also includes two vertical reference lines. One vertical reference line corresponds to the recommendation of 5 as the minimum expected cell count for the chi- squared statistic. The second vertical line corresponds to the minimum expected cell count in Table 8 from the TARS survey report.

For the chi squared test, the recommendation for a minimum expected cell count of greater than or equal to 5 seems reasonable, and the test results appear to be converging to the ideal value for larger values, which is desirable. It also seems clear that a chi squared test with a minimum expected cell count of 1.56 could easily result in invalid conclusions.

For the Goodman Kruskal gamma test, the results exhibit more variation than the corresponding chi squared test result, and also tend to be biased towards over-estimating the statistical significance (within the range of contingency tables that were simulated). Therefore the recommendation for the chi squared test of a minimum expected cell count of 5 does not seem to be reasonable, since the vast majority of cases would result in a substantial overestimating of the statistical significance. It is not even clear from these simulations, which were only run up to a minimum expected cell count of 10, that the Goodman Kruskal gamma test p-value is converging to the ideal value, although it is purported to do so as the total number of cell counts tend to infinity (e.g., the “Asymptotic Standard Error” converges to the actual standard error). It is clear that with a minimum expected cell count of 1.56, the statistical significance (p-value) will be greatly overestimated in a large number of cases.

Because of the limited amount of data available in the TARS survey, it is clear that both the chi squared and the Goodman Kruskal gamma tests are inappropriate. This leaves Fisher’s Exact test[1] as the best alternative, although it should be noted that this test is only exact for certain discrete outcomes, and tends to be conservative overall (i.e., the test tends to under predict the statistical significance of a table). As shown in Table 8, Fisher’s Exact test produces a p-value of 0.466, which is highly non-significant.

[1] Fisher’s Exact test was originally defined for 2x2 contingency tables. The test has been extended to larger dimension tables such as 2x3 tables by Freeman-Halton, and it is sometimes referred to as the Fisher-Freeman-Halton test.

Table 8. Comparison of tests for Table 8 from the TARS survey

Test	p-value
Pearson chi squared test	0.281[a]
Fisher's exact test	0.466
Goodman and Kruskal gamma test	0.019 [b]

[a]The chi squared test is not valid for table 8 from the TARS survey report

[b]The Goodman Kruskal test is not valid for table 8 from the TARS survey report

This means that the claim by the TARS authors that there is a statistically significant difference between the "Quadbar or Lifeguard" and "No OPD" (Table 8 from the "Quad bike and OPD workplace safety survey report") is not validly made.

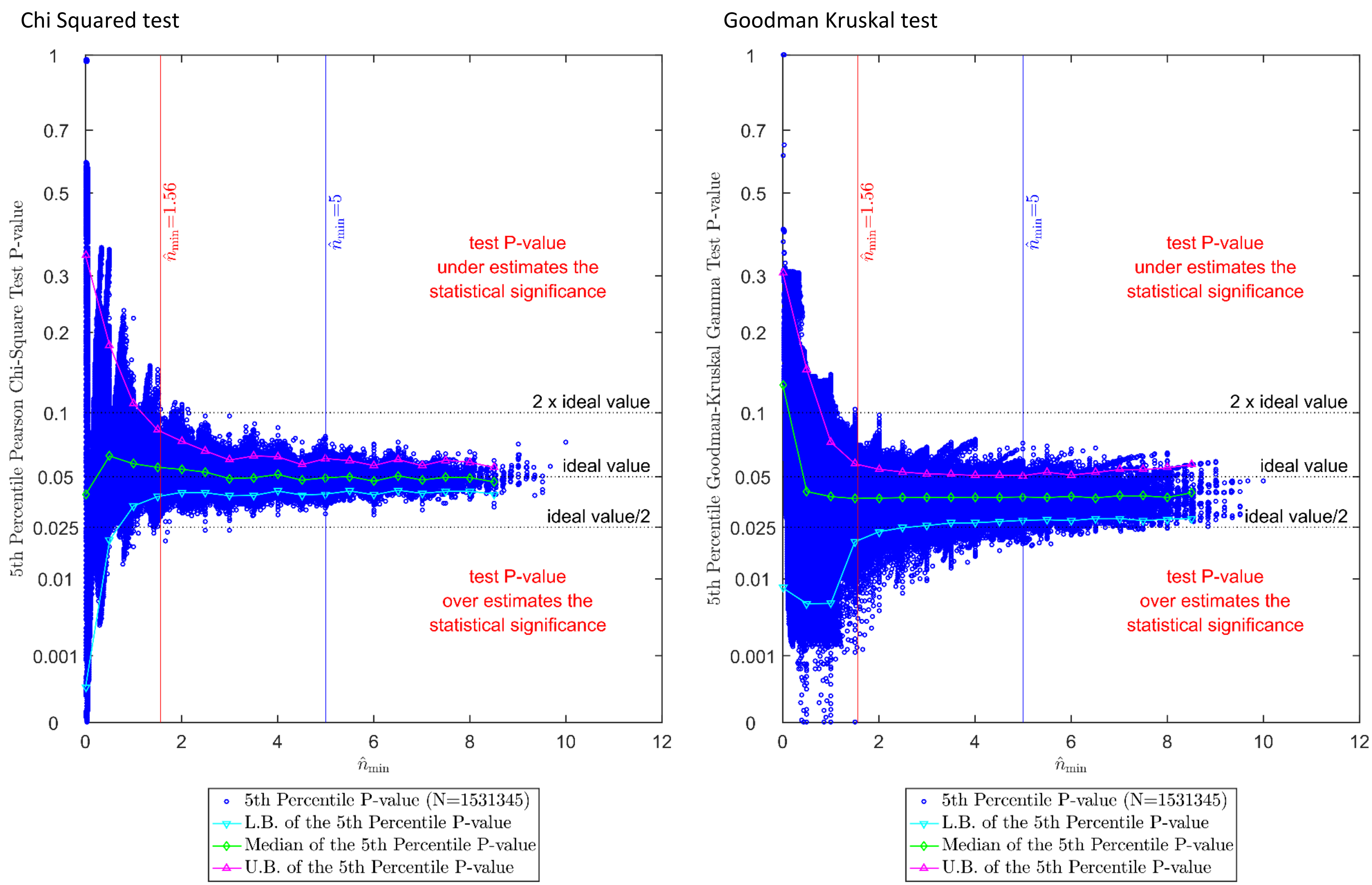

Figure 2. Comparison of the chi squared test and Goodman Kruskal gamma test as functions of minimum expected cell count

Annex 2

Pegasus review of the DRI statistical analysis

1. Introduction

Pegasus Economics was engaged by the Federal Chamber of Automotive Industries (FCAI) to critique the statistical analysis undertaken by Dynamic Research, Inc. (DRI) (Van Auken & Kebschull, 2018) in its review of the statistical methodology employed in the Quad Bike Workplace Safety Survey Report by the Transport and Road Safety (TARS) Research Centre (2017). The statistical analysis conducted by DRI focuses specifically results reported in Table 8 from a trend analysis in the Quad Bike Workplace Safety Survey Report (Transport and Road Safety (TARS) Research Centre, 2017, p. 42).

Pegasus Economic (Davey, 2017) previously critiqued the Quad Bike Workplace Safety Survey Report by the TARS Research Centre for the FCAI and found it to be seriously wanting:

> *In the opinion of this author the serious limitations in relation to the statistical techniques employed by the TAR Research Centre researchers renders their study and findings as largely meaningless.*

2. Background

Table 8 from the Quad Bike Workplace Safety Survey Report is a contingency table reporting on a trend analysis for Quad bike 'rolled over rider' crash chest Injuries (Transport and Road Safety (TARS) Research Centre, 2017, p. 42). A contingency table is where each row represents a category for one variable while each column represents a category for another variable (Statistics Solutions, 2019). In the case of Table 8, the rows represent the two categories of whether the Quad bike was fitted with a Quadbar or a Lifeguard Operator Protective Device (OPD) or not, while the columns represent three categories for the severity of a chest injury suffered, namely no injury, an injury not requiring hospitalisation, and an injury requiring hospitalisation.

According to the TARS Research Centre (2017, p. 42), Table 8 from the Quad Bike Workplace Safety Survey Report indicates that for cases where the Quad bike 'rolled over the rider' and a chest injury occurs and/or the rider is pinned, a trend analysis identified that with increasing severity of chest injury, the proportion of Operator Protective Devices (OPD) fitted vehicles decreases. This conclusion is reached on the basis of a gamma statistic for Table 8 that is statistically significant at less than the 2 per cent level.

Developed by Goodman and Kruskal (1954), gamma is a measure of statistical association between ordinal variables. Two ordinal variables are associated to the extent that a relatively high (or low) value on one can be predicted from a relatively high (or low) value on the other (Balch, 1979, p. 218). A pair of cases (respondents) is in the same order (concordant) if the same case is higher on both variables. A pair of cases is in different order (discordant) if one case is higher on the first variable and the other case is higher on the second variable. The value of gamma ranges from -1 to +1 where the later value indicates perfect agreement between the two rank orderings (Baker, 1974, pp. 443-444). The null hypothesis for the Goodman and Kruskal gamma test is zero – i.e. there is no association between the variables.

3. Dynamic Research, Inc. Review

The review by DRI (Van Auken & Kebschull, 2018) applies the application of three tests to Table 8 from the TARS Research Centre study. In addition to the Goodman and Kruskal gamma test run by the TARS Research Centre, the DRI review also applies the Fisher-Freeman-Halton (FFH) Exact test and the Pearson's chi-square test for independence to the contingency table data contained in Table 8 from the Quad Bike Workplace Safety Survey Report.[2]

The most commonly used statistical method for examining the association between two nominal variables is in fact the Pearson chi-square test for independence (Looney & Hagan, 2015, p. 243). The Pearson chi-square test for independence is used to determine if there is a significant relationship between two nominal (categorical) variables (Statistics Solutions, 2019). The frequency of each category for one nominal variable is compared across the categories of the second nominal variable. The Pearson chi-square test for independence tests the null hypothesis that the relative proportions of one variable are independent of the second variable; in other words, the proportions at one variable are the same for different values of the second variable (McDonald, 2014). In relation to Table 8 from the Quad Bike Workplace Safety Survey Report the Pearson's chi-square test for independence will test the null hypothesis that the severity of injury for Quad bike riders with a Quad bike fitted with a Quadbar or a Lifeguard OPD is exactly the same as the severity of injury for Quad bike riders with Quad bikes not fitted with a Quadbar or a Lifeguard OPD. A major drawback from the Pearson's chi-square test for independence is that it does display poor statistical properties if the frequencies in any of the cells of the contingency table are too small (Freeman & Halton, 1951).

As in the case of the Pearson chi-square test for independence, the FFH Exact test tests the null hypothesis that the relative proportions of one variable are independent of the second variable. However, the FFH Exact test overcomes the problems associated with the Pearson chi-square test for independence when expected and observed numbers are small (Freeman & Halton, 1951, p. 141). According to Professor Graeme Ruxton of the University of Glasgow and Professor Markus Neuhäuser of the Koblenz University of Applied Sciences (2010, p. 1508), the FFH Exact test is the most appropriate exact test for contingency tables larger than 2x2 and provides good control over type I errors.[3]

Table 2 of the review by DRI (Van Auken & Kebschull, 2018, p. 17) reports on the results from the three test on the data contained in Table 8 from the Quad Bike Workplace Safety Survey Report. It finds that the null hypothesis cannot be rejected in relation to both the Pearson chi-square test for independence and the FFH Exact test and on this basis concludes there is no statistically significant difference between the two treatments (i.e. in the underlying probabilities between the severity of injuries sustained by Quad bike riders with Quad bike fitted with a Quadbar or a Lifeguard OPD from the severity of injury for Quad bike riders with Quad bikes not fitted with a Quadbar or a Lifeguard OPD) (Van Auken & Kebschull, 2018, p. 16).

Given the problems in relation to the Pearson chi-square test for independence when expected and observed numbers are small as already discussed, we are inclined to discount the results of this test given the small number of observations in some of the cells contained in Table 8 from the Quad Bike Workplace Safety Survey Report. However, the results from the FFH Exact test means that one can have confidence in the finding that there is no statistically significant difference between the underlying probabilities between the two treatments.

The review by DRI (Van Auken & Kebschull, 2018) tested the properties of all three tests through a Monte Carlo simulation of 1,000,000 randomly sampled 2x3 tables in which the row and column variables were independent (i.e. equal underlying proportions). Monte Carlo simulations are used to model the probability of different outcomes in a process that cannot easily be predicted due to the intervention of random variables (Kenton, 2019). Based on the results of the Monte Carlo

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[2] For a description of the FFH Exact test see Freeman and Halton (1951). For a description of the Pearson's chi-square test for independence see Kenkel (1995, pp. 522-526).

[3] Type 1 error is the rejection of a true null hypothesis also known as a "false positive".

simulation, the review by DRI (Van Auken & Kebschull, 2018, p. 20) found that while the FFH Exact test for equal underlying proportions (i.e., independence) was uniformly distributed, and the Pearson chi-square test for Independence was approximately uniformly distributed, it found that the Goodman and Kruskal gamma test was not a good test for independence. In particular, it was found the Goodman and Kruskal gamma test performed poorly when there is a 0 value in one of the table cells (Van Auken & Kebschull, 2018, p. 21). On this basis, in the relation to the Goodman and Kruskal gamma test, the DRI review draws the following conclusions:

> *These results indicate that the [Goodman and Kruskal Gamma] test for association should only be used after a test for independence (i.e., equal underlying proportions) has rejected the null hypothesis for independence.* (Van Auken & Kebschull, 2018, p. 21)

In turn, the DRI review goes on to observe in relation to Table 8 from the Quad Bike Workplace Safety Survey Report that given there are not any statistically significant differences in their underlying proportions as suggested by the FFH exact test and the Pearson chi-square test for independence, that the results arising from a Goodman and Kruskal Gamma test for association are therefore meaningless (Van Auken & Kebschull, 2018, p. 21).

Conclusions

The DRI review is thorough and transparent in terms of its analysis and provides a logical and coherent line of reasoning in arriving at its conclusions. In the view of this author it is a highly credible study. The only criticism that we can level against the DRI review is its use of the Pearson chi-square test for independence in relation to Table 8 from the Quad Bike Workplace Safety Survey Report given the small number of observations in some of the cells. However, this shortcoming is overcome through its use of the FFH Exact test. On this basis, we concur with the overall findings from the DRI review. In particular, we strongly agree with the conclusion reached by DRI that the TARS Research Centre should have established independence before running the Goodman and Kruskal gamma test.

The DRI review stands in marked contrast to the quality of the statistical analysis conducted in the Quad Bike Workplace Safety Survey Report by the TARS Research Centre that provided almost no discussion of the statistical analysis that it undertook in relation to Table 8 or its appropriateness as such. It is also noted the Quad Bike Workplace Safety Survey Report heavily qualifies its conclusions in relation to Table 8 with the following suggestion:

> *… it is recommended that a larger sample size be obtained in the future to determine more precise estimates of the benefit of fitting Quadbar and Lifeguard OPDs to Quad bikes.* (Transport and Road Safety (TARS) Research Centre, 2017, p. 12)

Furthermore, the Quad Bike Workplace Safety Survey Report also provides the following disclaimers in relation to its overall statistical analysis:

> *There are also some limitations of this survey study, from a statistical perspective only. In particular, the number of OPD users responding to the surveys were less than expected, and consequently the number of OPD no-injury cases and related injury and serious injury cases are relatively low resulting in a lack of statistical power to be able to fully assess the effectiveness of such devices.* (Transport and Road Safety (TARS) Research Centre, 2017, p. 61)

> *This reference to the limitations of the study are purely from a statistical analytical perspective…* (Transport and Road Safety (TARS) Research Centre, 2017, p. 62)

In the opinion of this author, the disclaimers provided by the TARS Research Centre are nowhere near adequate enough to reflect the overall poor quality of statistical analysis that it undertook.

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