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AN EVALUATION OF QUEENSLAND'S GRADUATED LICENSING SYSTEM: ANALYSIS OF POLICE-REPORTED CRASH OUTCOMES, AND INDIVIDUAL GLS COMPONENTS

by

Michelle Scully,

Stuart Newstead,

& Michael Keall

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Title and sub-title: Evaluation of Queensland's Graduated Licensing System: analysis of police-reported crash outcomes and individual GLS components

Author(s): Michelle Scully, Stuart Newstead & Michael Keall

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Abstract:
The Queensland Government made substantial changes to the Queensland Graduated Licensing System (GLS) by introducing thirteen new initiatives on July 1 2007. The key initiatives included doubling the minimum holding period for all Learners (from 6-months to 12-months), requiring that Learners under the age of 25 years can only enter the Provisional licence phase once they have recorded in a logbook the accumulation of at least 100 logbook hours of driving experience in the presence of a supervisor, dividing the Provisional licence period into two phases (P1 and P2), and restricting P1 drivers to carrying no more than one peer passenger aged under 21 years during the hours of 11pm to 5am. This study has established a framework for comprehensive evaluation of the new GLS in Queensland. It has the capacity to measure the effectiveness of the GLS both at the global level and within a range of specific levels of detail including by licence phase, licence phase progression groups and for specific elements of the GLS. The framework has been applied to estimate preliminary effects of the new GLS and its component regulations on crashes, infringements and novice driver behaviours.

The primary evaluation estimated the crash reductions associated with the Queensland GLS from July 2007 onwards. Implementation of the GLS was associated with a statistically significant 31% reduction in fatal crashes involving novice drivers with the estimated crash reductions diminishing with reducing crash severity. When considering only licence holders who have been through at least one licence phase under the new GLS, the same pattern in crash reduction estimates by crash severity were observed. When considering crash reductions by licence phase and crash severity, highly statistically significant crash reductions were estimated for fatal crashes amongst P1 licence holders, fatal and serious injury crashes involving learner drivers, and all reported crashes involving learner and P2 drivers. Marginally statistically significant crash reductions were also estimated for open licence fatal crashes, and fatal and serious injury P1 drivers. The final analysis estimates the crash effects associated with those who complete all the new GLS licensing phases and showed statistically significant reductions in all reported crashes and fatal and serious injury crashes combined in the learner phase for this treatment group of 28% and 41% respectively. The evaluation also considered the effects of the new GLS on infringements as well as the specific effects of GLS regulations relating to high powered vehicle restrictions, hazard perception test and peer passenger restrictions. Self-reported behaviours in response to the GLS were also analysed.

Limited quantities of crash data from the period after the implementation of the new GLS on which to run the evaluation framework severely limited the range of more specific results that could be obtained from the evaluation. It is recommended that the evaluation be revisited when 2-3 years of additional crash data are available.

Key Words:
Graduated driver licensing, novice drivers, hazard perception testing, high-powered vehicle restriction, self-reported driving behaviours, peer passenger restriction, Learner driver logbook, mobile phone restriction, motorcycle Learner crashes, police-reported crash analysis, statistics, injury outcome, evaluation

Monash University Accident Research Centre,
Building 70, Clayton Campus, Victoria, 3800, Australia.
Telephone: +61 3 9905 4371, Fax: +61 3 9905 4363

www.monash.edu.au/muarc

Preface

Research Team Contribution

Stuart Newstead – project manager, evaluation methodology, primary evaluation statistical analysis, secondary evaluation statistical analysis, report-write-up

Michelle Scully – literature review, evaluation methodology, data preparation, secondary evaluation analysis, report write-up

Michael Keall (University of Otago, New Zealand) –evaluation of high-powered vehicle restriction

Dorothy Begg (University of Otago, New Zealand) - project consultant

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Contents

Figures

Tables

EXECUTIVE SUMMARY

The Queensland Government made substantial changes to the Queensland Graduated Licensing System (GLS) by introducing thirteen new initiatives on July 1 2007. The key initiatives included doubling the minimum holding period for all Learners (from 6-months to 12-months), requiring that Learner drivers under 25 must accrue 100 hours of supervised on-road driving experience and record it in a Queensland Learner Logbook, dividing the provisional licence period into two phases (P1 and P2), and restricting P1 drivers to carrying no more than one peer passenger aged 16-23 years during the hours of 11pm to 5am.

In 2009, Queensland Transport and Main Roads commissioned the Monash University Accident Research Centre to evaluate the effectiveness of the new GLS. The overall aim of the evaluation was to determine the effectiveness of major and supporting initiatives within the new GLS in contributing changes in the number of people killed or injured through involvement in a crash with a novice driver. The study comprised a Primary and Secondary Evaluation. The Primary Evaluation aimed to assess the effectiveness of changes introduced to the GLS on 1 July 2007 on police reported crashes. The Secondary Evaluation aimed to assess the effectiveness of individual initiatives of the GLS. The definition of a novice driver within the context of this evaluation is any driver that is licensed as part of the GLS (i.e. on an L, P, P1 or P2 licence).

The Primary Evaluation analysis aimed to evaluate the effects of the GLS at a number of levels:

1. Overall effects on road trauma in Queensland
2. Overall effects for novice drivers whose licensing conditions were somehow changed under the new GLS
3. By licence type (L, P1, P2 and Open)
4. By pre-defined treatment group as defined by the path through licensing defined by the new GLS regulations
5. For the principal treatment group which represents the path through the new GLS licensing levels that the majority of novice drivers will take in the future and hence is most representative of the likely long term effectiveness of the program

The first stage of the study undertook a comprehensive literature review identifying each of the key components of GLS internationally as well as the established methodology for undertaking comprehensive evaluation of the crash effects of GLS implementations. The review identified the rationale for the 13 key components of the new Queensland GLS and explored the existing evidence for the likely crash effects of each key component. It also reviewed the existing published evaluations of GLS implementations internationally to identify the most appropriate methodology to use in this study.

Based on the best practice evaluation methodology from existing international literature, the evaluation design chosen for assessing crash effects associated with the Queensland GLS was a quasi-experimental design. Changes in novice driver crash rates by licence type from before to after the introduction of the new GLS were compared parallel changes in a comparison group to estimate the crash effects of the new GLS in isolation from all other factors potentially influencing crash rates. The comparison group was defined as Open licensed car drivers aged between 25-35 years and were chosen to purposefully share similarity to the treatment groups in age, and to have completed their progression through

the GLS. The comparison group represents the time based changes in broad crash risk for all non-GLS related road safety initiatives in Queensland occurring during the study period, including the introduction of other road safety programs such as road-side drug testing, increased number of speed cameras, changes in travel and socio-economic influences such as unemployment rate as well as environmental influences such as weather.

The novice driver groups post GLS introduction were stratified into 10 groups according to their progression through various stages and conditions of the licensing system as defined by the new GLS regulations. Contrasting the differential crash effects associated with the GLS between these 10 groups gave the potential to measure the specific effects of various elements of the new GLS restrictions. Crash rates within each licence type in each of the 10 groups defined were compared with the comparable licence phase in the old GLS system. Crash rates rather than raw crash counts were used as the outcome measure in order to control for differing numbers of licensed drivers in each licence level in each treatment group over time. The denominator of the crash rate outcome measure used was the number of person months of licensure. Specific distance travelled by each group was not available for analysis.

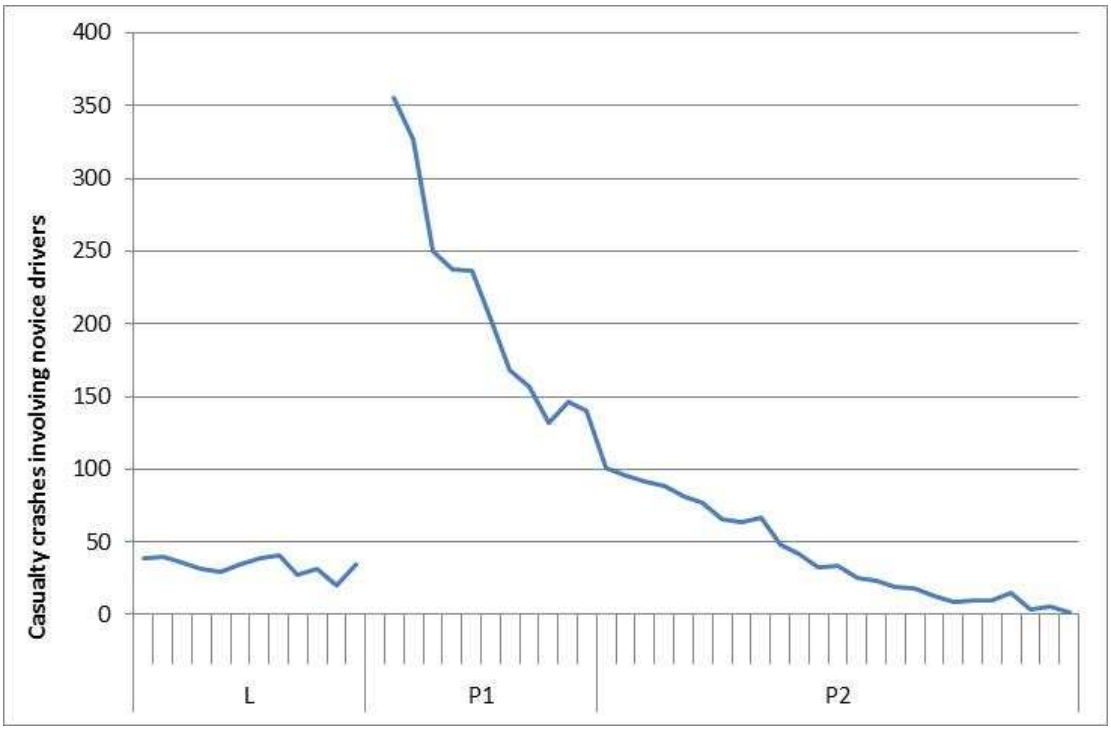
Crash data available for analysis covered different time periods depending on the crash severity level. The following data periods were used in the evaluation:

- July 2004 – December 2009 for police-reported crashes of all severity
- July 2004 – December 2010 for hospitalisation police-reported crashes
- July 2004 – November 2011 for fatal police-reported crashes

Reflecting the different data period availabilities, analysis was conducted for fatal crashes, fatal and hospital admission crashes combined and all reported crashes.

Figure A1 shows the number of all reported casualty crashes by licence type and months held for the post GLS period (July 2007 to December 2009). It has similar relative patterns between licence types as documented previously for the Queensland population of novice drivers. Trends in Figure A1 should not be taken as representative of novice driver crash risk since they have not been standardised by exposure. Furthermore, the number of crashes in the P2 phase is smaller than would be expected in the longer term since there has been limited opportunity for Queensland novice drivers to progress to the P2 licence stage within the study period.

Figure A1: Number of casualty crashes by licence phase and months held



Results of the analysis are given in Table A1 including estimated crash reduction associated with the GLS, the statistical significance of the estimate and upper and lower 95% confidence limits. Crash reduction estimates which are statistically significant at the 10% level are highlighted in order to identify these results for which there is some level of statistical confidence. Results which are statistically significant at the 5% level are also shown in bold to emphasis results with the greatest statistical reliability. The first block of analysis results gives the estimated crash reductions associated with the Queensland GLS as an entire intervention from July 2007 onwards. This analysis gives the total impact of the new GLS as implemented on novice driver road trauma in Queensland. The second block of analysis results assess the overall impact of the new GLS only amongst those licence holders who have been through at least one licence phase under the new GLS. This analysis gives a more pure estimate of the overall crash changes associated with the restrictions and requirements of the new Queensland GLS. Analysis results block 3 gives estimated crash reductions associated with the new GLS by licence phase and crash severity. The final analysis results estimate the crash effects associated with analysis Treatment Group 1 (TG1). This group is of primary interest as it covers those who complete all the new GLS licensing phases and is likely to be the group most representative of the long term crash effect of the new GLS in Queensland.

Table A1: Estimated Crash Reductions Associated with the new Queensland GLS

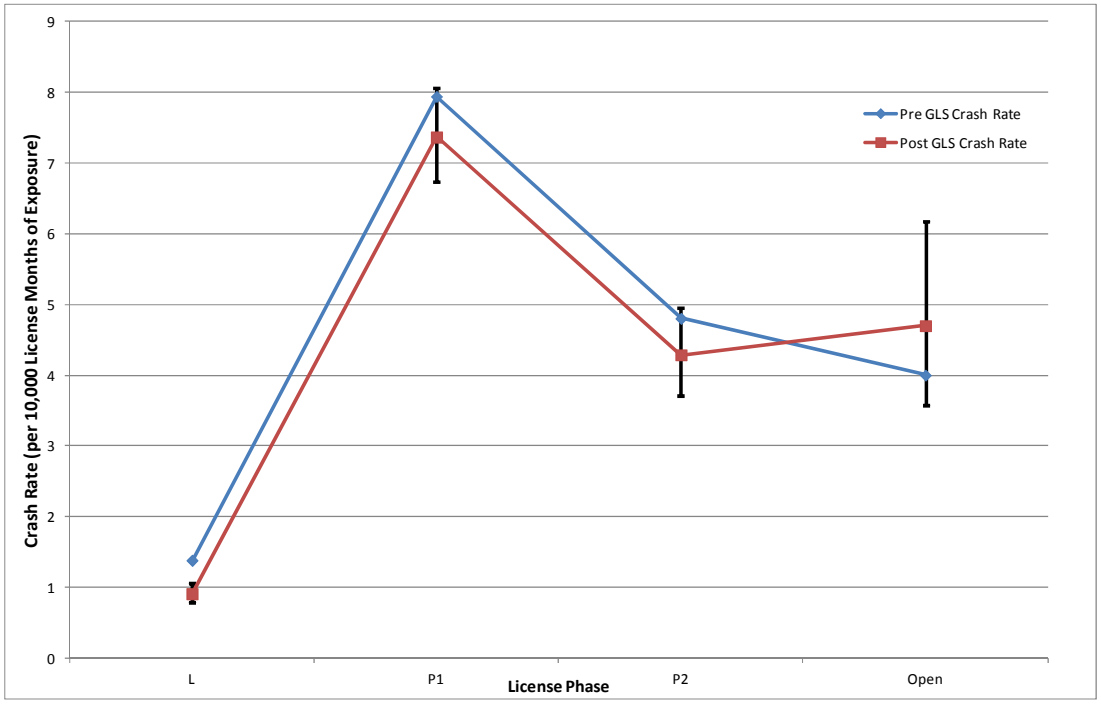
Analysis Level	Crash Severity	Licence Level or Group	% Crash Reduction*	Stat. Sig.**	95% Confidence Interval	
					Upper	Lower
Overall Program Including Old GLS	Fatal	All	**30.67%**	**0.0253**	49.70%	4.44%
	Fatal + SI	All	**13.23%**	**0.0000**	18.94%	7.12%
	All Crashes	All	**3.74%**	**0.0397**	7.17%	0.18%
Overall Program Only New GLS	Fatal	All	26.10%	0.0925	48.05%	-5.12%
	Fatal + SI	All	**9.13%**	**0.0113**	15.61%	2.15%
	All Crashes	All	1.27%	0.5347	5.19%	-2.80%
Only New GLS by Licence Type	Fatal	Learner	-286.72%	0.1929	49.51%	-2861.84%
		P1	**38.32%**	**0.0305**	60.18%	4.45%
		P2	-4.09%	0.9066	46.68%	-103.20%
		Open	59.03%	0.0787	84.85%	-10.77%
	Fatal + SI	Learner	**26.43%**	**0.0018**	39.30%	10.83%
		P1	7.24%	0.0994	15.18%	-1.43%
		P2	10.72%	0.1207	22.63%	-3.03%
		Open	-17.48%	0.2467	10.54%	-54.27%
	All Crashes	Learner	**12.73%**	**0.0088**	21.18%	3.36%
		P1	-2.76%	0.2503	1.90%	-7.63%
		P2	**10.32%**	**0.0068**	17.13%	2.96%
		Open	-15.32%	0.1383	4.49%	-39.25%
TG1 by Licence Type	Fatal	Learner	37.42%	0.7408	96.11%	-905.71%
		P1	27.20%	0.1836	54.40%	-16.23%
		P2	-3.41%	0.9310	51.56%	-120.73%
	Fatal + SI	Learner	**41.00%**	**0.0000**	52.97%	25.99%
		P1	-4.23%	0.4133	5.62%	-15.10%
		P2	-2.11%	0.8255	15.18%	-22.93%
	All Crashes	Learner	**28.08%**	**0.0000**	36.08%	19.07%
		P1	**-19.22%**	**0.0000**	-12.62%	-26.21%
		P2	5.13%	0.5604	20.55%	-13.28%

** NB: Negative crash reduction estimates indicate an estimated crash increase.*

*** Significance values of 0.0000 indicate a statistical significance of less than 0.0001*

Using the observed post new GLS crash fatal and serious injury crash counts and the estimated net crash effects associated with the new GLS the absolute numbers of crashes saved by the GLS by licence type over the period from July 2007 to December 2010 were estimated. The estimated total savings in fatal and serious injury crashes combined over this time period associated with the Queensland GLS was in the order of 430 of which around 260 were for learner licence holders, around 110 for P1 licence holders and around 70 for P2 licence holders. Figure A2 presents actual fatal and serious injury crash rates prior to the new GLS along with post new GLS crash rates adjusted for changes in the comparison group (open licence) crash rates as an illustration of the overall crash effects of the GLS over the study period.

Figure A2: Fatal and Serious Injury Crash Rates Pre and Post new GLS Introduction by Licence Type (Post GLS Crash Rates Adjusted for Changes in Comparison Group Crashes)



The secondary evaluation of the new Queensland GLS aimed to examine the effectiveness of a number of specific components of the system in greater detail on both crashes and intermediate measures of effectiveness including infringements, self-reported behaviours, hazard perception and vehicle choice. Key findings from the secondary evaluation are:

- The total number of offences detected related to new GLS driving conditions is very small as a proportion of the overall novice driver offence pool. This potentially suggests that novice drivers are relatively compliant with the new GLS regulations but more likely suggests that the intensity of enforcing GLS restrictions is not particularly high.
    - Enforcement of P plate display, peer passenger rules and late night driving curfews by police appears to be feasible, particularly when drivers are intercepted for other infringements.
    - Enforcement of the mobile phone rules, particularly related to supervisors and passengers, does not appear to be feasible.
    - Enforcement of the log book requirements also appears to be very lenient as learners who are considered to have falsified their logbook by Transport and Main Roads are provided the opportunity to rectify their logbook.

- Overall, introduction of the new GLS has been associated with a net reduction in the rate of all offences by novice drivers.
    - The exception to this is drink-driving where rates of offences have increased dramatically. This is most likely not due to the prevalence of drink driving amongst the novice driver population increasing but because of an increase in the ability of the police to detect zero BAC breaches for provisional licence holders due to them being readily identified with P plates. Blood alcohol test data recorded in the crash data supports this conclusion with the proportion of novice drivers involved in crashes with a non-zero blood alcohol concentration decreasing after introduction of the new GLS.
    - P1 drivers were the only licence class to record an overall net increase in the rate of offending driven by increases in unlicensed driving, hooning, drink driving and disobeying road signs.
    - Older novice drivers, who do not have to comply with all aspects of the new GLS, also showed increases in their net rate of a number of serious offence types including hooning, drink driving and disobeying road signs.
    - Those who progressed through all phases of the new GLS, representing the largest group of future novice drivers, recorded one of the largest decreases in overall offence rates and one of the smallest net increases in drink driving offences. Mobile phone offences were the only standout problem for this group.
- Self-reported behaviours and attitudes highlighted a number of issues about the new GLS
    - Although not representing the majority of learners, a proportion of the learner population enter false log book records or compromise the accuracy of recording by not entering records immediately after each driving session.
    - Although finding obtaining the required hours of learning onerous, many learners reported exceeding the hours and estimating that they would have reached the 100 hours even if it was not a requirement. Furthermore, despite the requirement being considered onerous the majority reported that they thought that gaining the 100 hours made them a safer driver.
    - A concern for P drivers is their general unhappiness with the peer passenger restrictions and the high proportion that admit to having contemplated or actually having breached the peer passenger restriction. A further concern is the high propensity of P drivers who are never or rarely accompanied by an experienced driver once on their P licence meaning they go from fully supervised to fully unsupervised at the time of obtaining the P licence rather than a gradual transition. The one mitigating factor is there remains a high degree of accountability to parents on trip destination and timing on the P licence phase.

- Young novice drivers transition from driving a relatively safe vehicle owned by their parent(s) during the low crash risk learner phase to a relatively unsafe vehicle owned either by themselves, or a secondary family vehicle allocated to them but owned by their parent(s) in the high risk P licence phase contributing to poor road trauma outcomes

- The high-power vehicle restriction analysis indicated that restricted vehicles are relatively rare in the vehicle fleet and that only small reductions in police-reported crashes (~1.4%) would result even with 100% compliance with the restriction which current data indicate is unlikely to be achieved. Consequently this aspect of the GLS is relatively ineffective in reducing novice driver road trauma.

- Evaluation of the effectiveness of peer passenger restrictions for P1 drivers was unable to establish any statistically significant effects of the restrictions on crash involvement and overall passenger injury rates. This was largely due to the limited number of crashes involving peer passenger injuries in the times where the restrictions apply. However, significant reductions in late night crash risk for both P1 and P2 drivers were measured. Analysis of infringement data and alcohol involvement in night time crashes suggests the majority of this reduction might have been attributable to more efficient enforcement of the requirement for zero blood alcohol and not the peer passenger restriction. Crash and self-reported data also suggest that compliance with peer passenger restrictions may be relatively poor.

- It was not possible to establish a general relationship between performance on the Hazard Perception Test (HPT) and crash involvement. The HPT requires further more detailed investigation into its effectiveness

- Analysis of changes in motorcycle crash rates associated with the introduction of the new GLS was inconclusive. This is due in part due to the lack of travel exposure data biasing crash risk estimates which were based only on months of licensing. It was also due to licensing data being used for the analysis not being specified specifically for analysis of motorcycle licensing.

This study has established an effective framework for comprehensive evaluation of the new Graduated Licensing System (GLS) introduced in Queensland on July 2007. It has the capacity to measure the effectiveness of the GLS both at the global level and within a range of specific levels of detail including by licence phase, licence phase progression groups and for specific elements of the GLS. However, limited quantities of crash data from the period after the implementation of the new GLS on which to run the evaluation framework severely limited the range and robustness of crash effects which could be estimated for driver populations and elements of the new GLS. The results that could be obtained raised some concern that the crash reductions estimated for the GLS overall to date may not be sustained although confirmation of this will require further analysis at a future time when a longer period of data after GLS implementation are available for analysis.

A key recommendation from the study is that the evaluation of the new Queensland GLS using the framework developed in this study be revisited when 2 to 3 years of additional crash data are available. Significant quantities of additional crash data will enable the production of more robust and wide ranging estimates of crash effects associated with the GLS. Further research is also recommended to better understand

specific aspect of the GLS including those where definitive conclusions could not be made in this evaluation due to a lack of relevant data.

1 INTRODUCTION

1.1 BACKGROUND AND REPORT OVERVIEW

On July 1 2007 the Queensland Government introduced a new Graduated Licensing System (GLS). It was the first major change to the licensing system since 1999. Thirteen initiatives aimed at reducing crash involvement of young drivers were introduced (see Table 1). In 2009, Queensland Transport and Main Roads commissioned the Monash University Accident Research Centre to evaluate the effectiveness of the new GLS.

1.2 AIMS OF THE GLS EVLUATION

The overall aim of the evaluation is to determine the effectiveness of major and supporting initiatives within the new GLS in contributing to a lower road toll in terms of people killed or injured through involvement in a crash with a novice driver. Within the evaluation there are two separate evaluations.

The Primary Evaluation aims to assess the effectiveness of changes introduced to the GLS on 1 July 2007 on police reported crashes. The Secondary Evaluation aims to assess the effectiveness of individual initiatives of the GLS. The definition of a novice driver within the context of this evaluation is any driver that is licensed as part of the GLS (i.e. on an L, P, P1 or P2 licence).

The major and supporting initiatives that represent the new GLS are displayed in Table 1. All initiatives directly relate to the GLS, other initiatives that were introduced around the GLS implementation date (for example, random roadside drug testing) are not the focus of the evaluation but are taken into consideration in the statistical analysis to control for confounding effects through the inclusion of a comparison group of drivers.

Table 1: GLS initiatives

Reducing the minimum age to obtain a Learner licence
Increasing the minimum Learner period
Logbook for gaining driving experience
Restricting mobile phone use among drivers
Restricting loudspeaker devices among passengers
Requiring that motorbike Learners hold a car licence
Two phase intermediate licence system
Compulsory L-plates and P-plates
Peer-passenger restrictions
High-powered vehicle restriction
Late-night driving restriction for disqualified or suspended drivers, or drivers subject to a Good Driving Behaviour period
Media package and educational tools
Hazard Perception Test for P1 licence holders before applying for P2 licence or Open licence

2 LITERATURE REVIEW

2.1 AIMS AND EVALUATION DEFINITION

The aim of this literature review is to provide theoretical support for the methodology used in the Queensland GLS evaluation. Therefore there will be a focus on the research evidence of specific licensing components that are included in the Queensland GLS, and the methodologies adopted for GLS evaluations.

A definition of an evaluation varies widely, due to evaluations encompassing a wide range of subject matter and scope (Thompson & Sacks, 2001). According to the Australasian Evaluation Society the term evaluation generally refers to the "systematic collection and analysis of information to make judgements, usually about the effectiveness, efficacy and/or appropriateness of an activity" (Australasian Evaluation Society, 2006, pg. 5). Program evaluations "refer to any set of procedures, activities, resources, policies and/or strategies designed to achieve some common goals or objectives" (Australasian Evaluation Society, 2006, pg. 5). As the GLS encompass policies designed to reduce crash risk of young drivers, the following GLS evaluation is considered to be a program evaluation. The following literature review is aimed at collating the information on evaluations of GLS in the past in order to develop the program evaluation methodology for the Queensland GLS.

2.2 RESEARCH PROBLEM

Queensland data from the year 2004 show that although drivers aged 17-24 years old accounted for only 13% of all licence holders, they account for 28% of the road toll (QT Discussion Paper, 2005). Around the world, road crashes are the leading cause of death among young people aged between 10 and 24 years. The World Health Organisation (WHO) report that approximately 400,000 people under the age of 25 years are killed in road crashes each year, whilst millions more are injured and disabled (WHO, 2007). A wealth of research demonstrates that the risk of being involved in a crash is highest during the first year of driving on an intermediate licence, and in particular in the first 6-months of this licence phase (Diamantopoulou, Skalova, Dyte & Cameron, 1996; Gregersen, 1996). A comparison of crash risk for the different licensing phases is presented graphically in Figure 1. Based on these findings, first year drivers are primary targets of road safety initiatives.

There are several reasons why young drivers have higher crash risks (Gregersen & Bjurulf 1996; VicRoads, 2002; Waller, 2003). These include:

- lack of driving experience;
- insufficiently developed cognitive and perceptual skills;
- failure to recognise or accurately assess risk;
- poor ability to anticipate, perceive, identify and, therefore, react to hazards;
- propensity to be over-confident and over-estimate their driving ability;
- tendency to drive in high risk driving conditions (i.e. night time driving, recreational driving, and driving with passengers); and,

- propensity to take more intentional or unintentional risks (i.e. drive at high speeds, with close following distances, and drive aggressively).

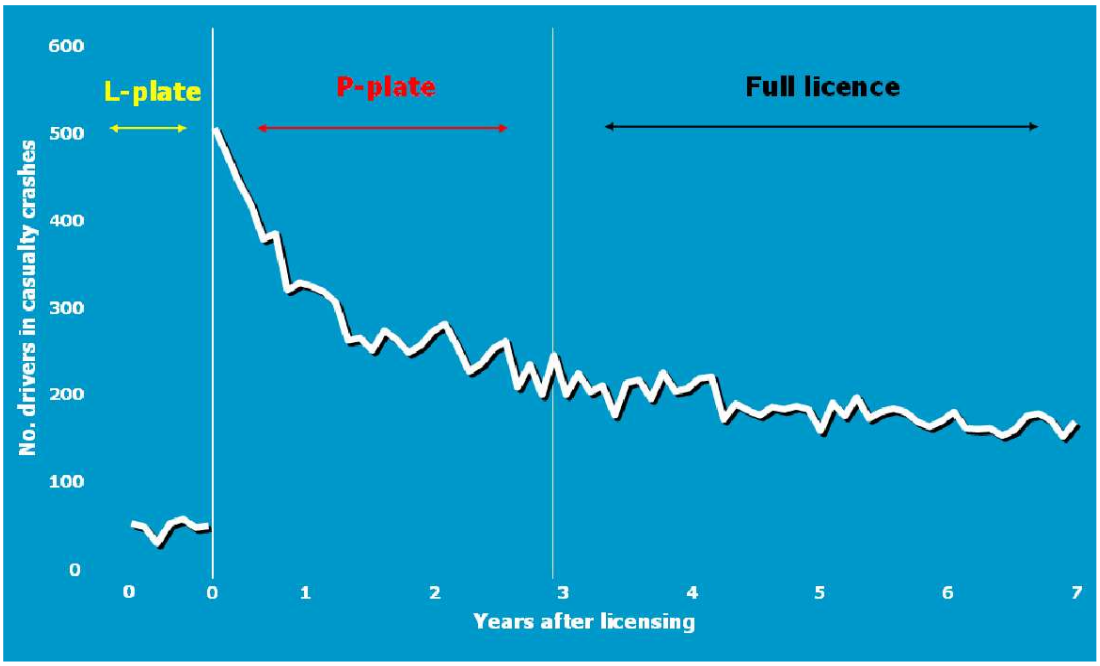


Figure 1: Relative Crash Frequency of Novice Drivers by Period of Licensure (Source: Queensland Transport (2007) Learner Driver Handbook)

2.3 THEORETICAL BASIS OF GLS

Figure 1 indicates that first year provisional (P-plate) drivers have the highest crash risk of any other licence type group. GLS are considered the most effective approach to addressing the overrepresentation of young drivers in crashes, given that most novice drivers are under the age of 25 years. Senserrick and Whelan's (2003) GLS review demonstrated that throughout Europe, North America and Australasia, GLS are a very common approach to addressing the overrepresentation of young drivers in crashes. GLS aim to reduce the crash risk of novice drivers by imposing restrictions on their driving to moderate the effects of youth and inexperience. Driving restrictions are gradually phased out as experience is gained. This allows novices to commence driving in lower-risk situations with gradual lifting of restrictions until a full licence is obtained. This creates a safer environment to allow the acquisition of skills while providing time for the benefits associated with maturity and experience to develop. In this way, a GLS is similar to an apprenticeship system (Simpson, 2003).

GLS vary greatly across jurisdictions. There are key features, such as gradually eased restrictions within a multi-phase system, but generally few if any systems are identical. The National Highway Traffic Safety Administration (NHTSA, 1998) outlines the aims of GLS as follows:

- expand and lengthen the learning process;
- reduce exposure to risk;
- improve driver proficiency; and,
- provide greater motivation for safe driving.

2.3 LITERATURE REVIEW BACKGROUND

A targeted literature review was conducted using key licensing search terms. The aim of the literature review was to provide research evidence to support the methodological approach to evaluating the Queensland GLS. There are two broad sections of this review. The first section outlines the research evidence for specific components of the Queensland GLS. Here, papers were included based on the following search methods:

- Evaluations that measure the effectiveness of specific GLS components whereby the components are included in the Queensland GLS. This includes national and state-based evaluations; and,

- Papers published from 2004 onwards, as two GLS reviews were published around this time. A report which focussed on the components of GLS around the world, (Senserrick & Whelan, 2003) and a Cochrane Review Of Systematic Databases (Hartling, Wiebe, Russell, Petruk, Spinola, & Klassen, 2004).

The second section of the literature review focuses on the experimental design and statistical methodology of GLS evaluations. This section also reviews papers published from 2004 onwards. To match the Queensland environment, only state-based evaluations are reviewed. National evaluations are not reviewed due to the fact that these studies relate to a different context than that of Queensland.

2.4 OUTLINE OF THE THIRTEEN INITIATIVES INTRODUCED INTO NEW GLS

This section relates the general aims of a GLS to the new initiatives introduced in the new Queensland GLS. A comparison of GLS requirements and restrictions under the old (pre-July 2007) and new (post-July 2007) GLS are shown in APPENDIX A.

Table 2: Thirteen newly-introduced Queensland GLS initiatives

Initiative	Rationale
Reducing the minimum age to obtain a Learner licence	Increasing driving experience with a supervisory driver, expanding and lengthening the learning process
Increasing the minimum Learner period	Increasing driving experience with a supervisory driver
Logbook for gaining driving experience	Increasing driving experience with a supervisory driver
Restricting mobile phone use among drivers	Reducing in-vehicle distractions
Restricting loudspeaker devices among passengers	Reducing in-vehicle distractions
Requiring that motorbike Learners hold a car licence	Ensures all motorcycle riders have a minimum amount of car driving experience & commenced developing motor and cognitive-related driving

	skills. It also ensures it is not possible to circumvent the car GLS by opting to get a motorcycle licence in lieu of a car licence
Two phase intermediate licence system	Achieving the basic theory of GLS in having multi-phases with gradual lifting of restrictions
Compulsory L-plates and P-plates	Visually identifying the driver is a novice so that greater caution can be exercised and to aid enforcement by identifying those for whom restrictions apply.
Peer-passenger restrictions	Reducing risks associated with carrying peer passengers
High-powered vehicle restriction	Eliminating exposure to high powered vehicles
Late-night driving restriction for disqualified or suspended drivers	Provide greater motivation for safe driving and to reduce exposure to higher risk environments for those detected engaging in higher risk driving
Media package and educational tools	Communicate GLS changes effectively & encourage parental involvement
Hazard Perception Test	Assess a driver's ability to quickly and accurately identify and respond to hazards

2.5 EVIDENCE FOR THE EFFECTIVNESS OF NEWLY INTRODUCED GLS COMPONENTS

This section details previous research that reports on the effectiveness of the thirteen initiatives that were introduced on 1st July 2007. The structure of this will be to first outline the aims of the initiative within the context of the NHTSA (1998) aims, and then to outline the available research evidence using GLS evaluations. Where GLS evaluations have not been able to isolate the effects of a specific component, the non-GLS research evidence will be briefly summarised. Non-GLS research evidence includes laboratory based studies, as opposed to GLS program evaluations, for example, assessing hazard perception skills in a driving simulator as opposed to assessing the effectiveness of the hazard perception test as a part of the GLS from real world data.

2.5.1 Lowering the minimum age to obtain Learner licence

Queensland lowered the minimum age to obtain a Learner licence from 16.5 years to 16 years (Queensland Transport, 2007). Theoretically, the aim of lowering the minimum age to obtain a Learner licence (assuming the minimum entry age to obtain an intermediate licence is unchanged) is to expand and lengthen the learning process so that drivers can increase driving experience under supervised and hence low-risk driving conditions.

Evaluations that assess the effectiveness of lowering the minimum age to obtain a Learner licence have collectively shown mixed results (Senserrick & Whelan, 2003).

Two evaluations have been published from Sweden and Norway. Sweden lowered the minimum Learner age from 17.5 years to 16 years and Norway lowered the minimum Learner age from 17 years to 16 years. Both countries' minimum age to obtain an intermediate licence was unchanged at 18 years. The evaluation of the Swedish licensing system results indicated that there was a reduction in crashes for novice drivers following the lowering of the minimum age to obtain a Learner licence (Gregersen, 1997). The Norwegian evaluation found no reduction in crashes after lowering the minimum Learner age (Sagberg, 2000, cited in Senserrick & Whelan). It is not possible to extrapolate such results to conclusively determine whether such a restriction will be effective in another GLS, such as Queensland.

2.5.2 Increasing the Learner licence minimum holding period

Queensland increased the minimum holding period for the Learner licence (Queensland Transport, 2007) from 6-months to 12-months. This applies to all Learner drivers regardless of their age when applying for the Learner licence. The aim of this component is similar to the aims of lowering the minimum age to obtain a Learner licence. Increasing the minimum holding period on the Learner licence aims to expand and lengthen the learning process so that driving experience can be gained under low-risk conditions.

Evaluations assessing the effectiveness of increasing the Learner licence holding period have shown an increase in the amount of driving experience gained in the Learner phase and a subsequent reduction in crashes (between 5-32% across 11 jurisdictions) in the intermediate phase (McKnight & Peck, 2002). The reductions in crashes following the increased Learner licence holding period were attributed to both the improved skills developed during the increased supervised practice period, and the subsequent delay in licensure.

2.5.3 Requiring minimum driving hours to gain intermediate licence

The Queensland GLS introduced the requirement that all Learner drivers under the age of 25 years must attain 100 logbook hours (10 hours must be during night time hours) of supervised driving experience before being eligible to apply for an intermediate licence (Queensland Transport, 2007). For drivers over the age of 25 years this requirement is voluntary. If Learners receive professional driving instruction the number of supervised hours decreases. For a one-hour lesson this equates to 3 hours of driving experience that can be recorded in the logbook (with a maximum of ten 1-hour lessons from a professional instructor – deemed equivalent to 30 hours of non-professional instruction - to be recorded in the logbook). It was estimated that mandating 100 hours of supervised driving would more than double the number of hours that Learners gained previously (Queensland Transport, 2007). Mandating 10 hours at night also increases the range of driving conditions experienced by Learner drivers. The aim of this requirement is to ensure that all Learner drivers gain a specified number of driving hours, and to increase driving experience under low-risk conditions.

Requiring that logbooks of driving experience be recorded is based on research demonstrating that attaining on average 100-120 hours of driving experience during the Learner licence phase significantly reduces the likelihood of crash involvement in the intermediate licence phase (Gregersen, 1997). However, there is a significant compliance issue that surrounds this requirement which can potentially influence the

effectiveness of this GLS component. There are no studies to date that evaluate this component in terms of crash risk. The introduction of mandatory logbook hours was designed to increase driving exposure, albeit in lower risk situations. It is possible that an unintended consequence to the increase in driving exposure may be an increase in crashes in the learner period. By examining the number and severity of crashes during the learner licence period (in comparison with the learner licence period under the old-GLS) it will be possible to assess whether the logbook hours increased crashes in the learner period and whether any change in crash severity was observed.

Preliminary research in Western Australia by Palamara (2007) investigated the reliability and validity of a small sample of Learner driver logbooks (N=41). Palamara indicated that overall, the logbooks were reliable with respect to completeness and consistency of information from the supervisor. At a general level the logbooks were considered to be valid in terms of accurate calculation of trip time and total hours of supervised driving. Palamara cautioned that some Learners and supervisors may be overstating the time and distance travelled for some trips. Palamara found that it was very difficult to obtain evidence of logbooks containing false or misleading information. Results of the evaluation were preliminary and there are quite significant differences between this GLS requirement in Western Australia (25 hours) in comparison to Queensland (100 hours). An important aspect of the current evaluation will be to assess this logbook component in terms of acceptability and compliance among young drivers and their parents. These findings will be discussed in relation to a recent study comparing the New South Wales and Queensland learners regarding factors that influence their driver experiences (Bates, Watson, & King, 2009).

2.5.4 Restricting mobile phone devices

The Queensland GLS introduced a new restriction on Learner and P1 licence holders and their passengers. Learner drivers and P1 drivers are not permitted to use a mobile phone of any kind including hands-free, blue tooth or those with a 'speaker phone' function. The aim of this restriction is to limit driving under high-risk situations by reducing the likelihood of in-vehicle distractions. This restriction is lifted at the P2 phase of licensure.

Foss et al. (2009) evaluated the mobile phone restriction which was introduced in North Carolina in 2006. This was the first study to investigate the effects of a mobile phone restriction within a GLS, on the behaviour of young drivers. They observed teenagers in North Carolina before and after the law came into effect, and in South Carolina where no change in the law occurred. The results indicated that mobile phone use did not significantly decrease in North Carolina after the law was introduced in comparison with pre-law, or in comparison with the state of South Carolina. Overall, teenagers were more likely to indicate that they knew about the restriction than parents. However, the difference in the proportion of teenagers indicating they were aware of the law pre- (59%) and post-implementation (64%) was minimal. Parents were more likely to support the restriction than teenagers. Prior to implementation of this restriction, approximately half of the teenagers and parents thought the law would be rarely or never enforced. After implementation a larger proportion of teenagers and parents reported that enforcement was rare or non-existent. These results indicated that the law was not successful in changing the behaviour of teenagers with regard to mobile phone use and perceived level of enforcement is argued to be a significant contributor to these findings. Foss et al. reported that enforcement was difficult due to difficulties in ascertaining a driver's age, and the issues surrounding identifying hands-

free mobile phone use. The Queensland GLS requirement for L and P-plates to be displayed may partially address this limitation.

2.5.5 Restricting communication devices among passengers

The Queensland GLS introduced a new restriction on all supervisors and passengers of Learner and P1 drivers. Supervisors and passengers of Learners, and passengers of P1 drivers are not permitted to use any mobile phone or loudspeaker (but they are permitted to use a hands held or hands-free mobile phone although it is not recommended). The aim of this restriction is to limit driving under high-risk situations by reducing the likelihood of in-vehicle distractions. This restriction is lifted at the P2 phase of licensure (Queensland Transport, 2007). There is no prior evidence on the likely effectiveness of this measure.

2.5.6 Requiring riders gain drivers licence before motorcycle licence

Queensland introduced a requirement that applicants for the Learner motorcycle licence must have held their P1 car drivers licence or full licence for a minimum of 12-months (in the past five years). This requirement is aimed at ensuring that motorcyclists gain on-road experience under comparatively low-risk conditions (driving a car). This is consistent with the aims of GLS as described by NHTSA (1998). Haworth and Mulvihill (2005) point out that gaining a truck licence involves similar restrictions. This initiative is relatively new and therefore there are no evaluations regarding the effectiveness in terms of crash reductions for novice motorcycle riders.

2.5.7 Two-phase intermediate licence structure

Queensland introduced a two-phase intermediate licence phase whereby drivers progress from the Learner licence to the P1 phase and then P2. The aim of this initiative is to structure the GLS so that there is a gradual progression of phases and restrictions are gradually lifted as driving experience is gained. There are no evaluations that assess the effectiveness of this initiative.

2.5.8 Compulsory displaying of identifying plates

The new GLS in Queensland introduced the requirement for novice drivers to display Learner (L-plate) and P plates (P1, red, P2, green). Previously there was no requirement for novice drivers to display L- and P-plates. The aim of this requirement is for other road users to be aware that the driver is a novice, to aid enforcement, and to limit novice drivers from risk-taking whilst displaying their licence status. There have been no evaluations that assess the effectiveness of this requirement. However, Senserrick and Whelan (2003) report that the crash reductions that were identified following the implementation of a new Norwegian GLS were partly attributed to the compulsory displaying of identifying plates. Studies in the US often cite police based enforcement of GLS restrictions as a significant issue due to the relatively few jurisdictions that require identifying plates to be displayed.

2.5.9 Mandating peer passenger restrictions during the intermediate licence period

One of the major changes to the GLS in Queensland was the introduction of a passenger restriction for all P1 drivers under the age of 25 years. This passenger restriction mandates that P1 drivers can only carry one passenger under the age of 21

years between the hours of 11pm and 5am. There are exemptions for passengers that are immediate family members and if the P1 driver is being supervised. Between the years 2004-2007 there was much public debate about the introduction of peer passenger restrictions, and prior to 2007 there were no Australian jurisdictions with a peer passenger restriction. Queensland, Victoria and New South Wales were the first three states that introduced peer passenger restrictions.

Passenger restrictions aim to reduce the crash involvement risk of both novice drivers and the peer passengers that they carry. Around the world peer passenger restrictions are a common component of the intermediate phase of a GLS. New Zealand and 37 North American jurisdictions (Williams, Ferguson & McCartt, 2007) include peer passenger restrictions in their GLS models.

The Senserrick and Whelan (2003) review indicated that peer passenger restrictions show clear associations with crash risk. Interestingly, the Cochrane Review by Hartling et al., (2004) only included one paper that specifically evaluated the effectiveness of the peer passenger restriction. The findings indicated that there was compliance with the passenger restriction; however, the effectiveness was not clearly reported. Hartling et al. indicated that while evidence to support peer passengers existed, their level of effectiveness is mixed. Since these two reviews were published there have been several studies reporting the results of the effectiveness of peer passenger restrictions in reducing crash risk.

Williams et al. (2007) conducted a review of the literature on crash risks of novice drivers carrying passengers. They argued that peer passenger restrictions were effective, and they also outlined a range of other initiatives that could be adopted to reduce crash risk, and to change in-vehicle behaviour. Williams et al. also concluded that crashes involving peer passengers were one of the most important road safety problems for young people, suggesting that peer passenger restrictions should therefore be part of the GLS in every US state, in addition to enforcement initiatives.

One of the problems of evaluating the effectiveness of peer passenger restrictions is that they often exist within a GLS that also imposes a night time driving restriction. If both restrictions are included then the night time driving restriction automatically overrides the peer passenger restriction for carrying passengers at night. However Williams et al. points out that the great majority of young driver crashes involving teenage passengers occur during the day with particular high risk periods being just before and just after school, late afternoon and early evening. This has important implications for the Queensland GLS where the peer passenger restriction only applies to night time hours. The results of the peer passenger restriction evaluations reported here generally include a night time driving restriction. As such generalising the results to a GLS with no night time restriction may not be appropriate. The following section presents the findings from GLS evaluations with a peer passenger restriction.

Three Californian evaluations of peer passenger GLS restriction have been published (Cooper & Gillan, 2004, 2005; Masten & Hagge, 2004). Prior to 2007 there were no Australian jurisdictions with a peer passenger restriction. Cooper and Gillan (2004, 2005) evaluated California's GLS which was changed in July 1998, including a peer passenger restriction for the first 6-months of the intermediate licence period. This restriction prohibits intermediate drivers from carrying passengers under the age of 20 years unless supervised. Comparisons of the rate of at-fault crashes for 16-year-old drivers carrying teenage passengers were made to not-at-fault crashes among the same

group carrying teenage passengers. A two-sample *t*-test assuming unequal variances demonstrated that these groups were significantly different; the crash rate of at-fault crashes among 16-year-olds carrying passengers was higher than the crash rate of the same group involved in non-at-fault crashes. The same test was carried out for 17-19 year-olds, 20-24 year-olds, and 25-54 year-olds. The results showed that teenage passengers remain a risk to 17-19 year-old drivers, with passenger presence significantly higher in at-fault crashes of this age group of drivers. For drivers aged 25-54 years, the differences were also statistically significant however they were in the opposite direction. That is, teenage passengers appear to lead to safer driving in older drivers. This interesting finding was not explored any further. Despite the inability to enforce this restriction, the authors argued that based on the estimation of lives saved (29) and injuries prevented among peer passengers (2,632), that the peer passenger restriction was effective.

Masten and Hagge's (2004) evaluation of the Californian GLS indicated that night time and peer passenger restrictions were found to be associated with significant reductions in serious injury or fatal crashes. The 6-month passenger restriction resulted in an annual saving of 816 fatalities and serious injuries, and the 12-month night time restriction resulted in an annual saving of 55 fatalities and serious injuries for the period 1994 to 2001. Masten and Hagge indicated that these reductions were not large, however they were the first US study to demonstrate a clear reduction in fatalities and serious injuries following the implementation of a night time and peer passenger restriction.

Hyde, Cook, Knight and Olson (2004) evaluated the Utah GLS which was phased in over a two-year period commencing July 1 1999. The law states that from July 1 2001, teenage drivers are not permitted to carry passengers under the age of 21 unless accompanied by a supervisor. This restriction is lifted after the first 6-months of driving on the intermediate licence. There is little difference between the Californian peer passenger restriction and the Utah peer passenger restriction. The results of the Utah evaluation indicated that there were few to no changes in crash rates involving peer passengers for pre- and post-GLS implementation, and also no change in the number of serious injury crashes occurring after the new GLS was implemented. The issue of enforcement, which was also discussed in the Cooper and Gillen (2005) study, was cited by the authors as an issue because there was almost no distinction between fully-licensed drivers and provisional licensed drivers which makes detection by Police difficult. This study indicates that the peer passenger restriction was not effective, and the low level of enforcement was cited as being a contributory factor. It is argued that low levels of enforcement cannot solely be attributed to crash rates involving peer passengers post-GLS. Understanding the compliance of this restriction among young drivers and their parents is also important because it is generally agreed that parents are the best enforcers of a GLS (Raymond et al., 2007).

The issue of compliance has been examined by Raymond et al. (2007). Raymond et al. evaluated the perceptions of the Oregon GLS which was introduced in May 2000. Separate focus groups were conducted with parents, teenagers, law enforcement officers, DMV road test administrators, driving instructors, and high school administrators to understand the opinions and experiences of various groups affected by the new GLS. There was strong support for the GLS across all groups. Parents were aware of the peer passenger restriction; some indicated that the increase in teenagers driving separately as a result of the passenger restriction concerned them from an exposure point of view. Whilst parents believed that the peer passenger restriction was

the most important rule, they also thought that their children were most likely to violate this restriction. For the teenagers, the peer passenger restriction was considered the most concerning element of the GLS. Interestingly, it was reported by many teenagers that as they gained confidence and realised they were unlikely to be detected when carrying peer passengers, they gave in to the constant pressure from their peers to provide rides, therefore violating the peer passenger restriction.

The focus groups involving professionals indicated that there was not only support for the GLS but arguments that the GLS should be stricter. Overall parents were seen to be the major sources of enforcement, and peer pressure was seen as the most common cause of non-compliance (Raymond et al., 2007). This study indicates that on the one hand parents are likely to have the most success in enforcing the peer passenger restriction in comparison to other sources of enforcement, but on the other hand parents are also likely to find enforcing this restriction difficult in comparison to other GLS components. Enforcement is not easy to maintain because parents perceive that this restriction is an imposition for their young driver, and that compliance is unlikely due to strong peer pressure. Similar to the results from the focus groups with teenagers, professionals agreed that teenagers are likely to succumb to this peer pressure once they have gained confidence and realise that it is unlikely that they will be caught violating the restriction.

Several national US evaluations have been conducted (Williams, Ferguson, & Wells, 2005; Chen, Baker, & Li, 2006; Morrisey, Grabowski, Dee & Campbell, 2006; McCartt et al., 2009), and some have provided insight specifically into the effectiveness of a peer passenger restriction (Chen, et al. 2006; McCartt et al., 2009; Williams et al., 2005; Morrisey et al., 2006). Chen, et al. (2006) conducted a national evaluation of GLS using the Fatality Analysis Reporting System (FARS). The analysis included an investigation of the effectiveness of the peer passenger restriction. There were 21 states that had a passenger restriction, and 22 states that did not include a peer passenger restriction in their GLS. Unfortunately it appears that due to the nature of the statistical analysis (binomial regression), the exact nature of the restriction was not defined. Restrictions were simply categorised as either peer passenger restriction present or not present in the GLS. Consequently identification of the type of peer passenger restriction that is most effective is not possible. However, the results of the regression model provide an interesting overview of essential components that should be included in a GLS, based on data from 43 US states over the period 1994-2004.

The various components of the GLS were defined by seven categories: minimum age for Learner licence; mandatory waiting period before obtaining intermediate licence; minimum hours of supervised driving; minimum age for intermediate licence; minimum age for full licensing; night time restriction; and a peer passenger restriction (Chen et al., 2006). The results showed that compared with states with no GLS, significant reductions (ranging from 16%-21%) in fatal crashes involving 16-year-old drivers were associated with a GLS that specifically included both a minimum waiting period of at least 3 or more months after obtaining a Learner licence before obtaining an intermediate licence and a night time restriction, plus, either a peer passenger restriction during the intermediate phase, or, 30 or more hours of supervised driving on the Learner licence phase. This study indicates that peer passenger restrictions are effective when combined with certain other components of a GLS.

The most recent national evaluation of a GLS was published by McCartt et al. (2009). Poisson regression was adopted to examine the fatality rate of involvements per

100,000 drivers between the years 1996-2007 using the FARS database. The results of the peer passenger restrictions showed a decrease in crash risk with decrease in the number of peer passengers allowed: the novice driver crash rate for 15-17 year-olds was 21 percent lower when prohibited from carrying peer passengers compared to when two or more passengers were allowed. Furthermore, if novice drivers were permitted to carry one passenger, the results showed that this reduced the fatal crash rate for 15-17 year-olds by 7 percent. This study is regarded as a comprehensive evaluation, and the analysis of the peer passenger restriction is therefore considered to increase the overall body of knowledge regarding this GLS component. The results are particularly informative as they delineate between peer passenger restrictions of varying forms - ranging from allowing no passengers in comparison to restrictions allowing two or more passengers. However it is not specified whether only peer passenger data was used or passengers of any age.

Williams et al. (2005) used data from the FARS database for the period 1993-2003 to conduct a national evaluation of peer passenger restrictions among 16-year-old drivers in the U.S. Results showed that overall there was a reduction in crashes involving 16-year-old drivers, from 1,084 in 1993 to 938 in 2003. Whilst the crash characteristics between the 1993 to 2003 remained unchanged, the percentage of drivers transporting peer passengers decreased from 53% to 44% which was attributed to states adopting night time and peer passenger restrictions. Interesting results were revealed for a specific analysis on the effectiveness of the night time and peer passenger restrictions. The analysis of all states showed that 65% of 16-year old driver fatal crash involvements in 1993 were either at night (11%) or when transporting young passengers at another time of the day (54%). In comparison, 2003 data showed a reduction in these figures, whereby 56% of 16-year-old fatal crash involvements were either at night (10%) or carrying passengers at another time of day (46%).

Williams et al. reported that "the difference was due entirely to less frequent crashes involving transportation of young passengers" (Williams et al., 2005, p 204). The results of the analysis of only the 30 states that had enacted a night time and/or peer passenger restriction sharpened in comparison to the analysis of all states. Furthermore in states without these restrictions there were no significant differences in the crash rates for night time and/or peer passenger restrictions. Interestingly an analysis was carried out for 21 states that added only a passenger restriction. The results showed that 57% of the fatal crashes in 1993 in comparison to 43% in 2003 involved transport of young passengers during the day. Furthermore 63% in 1993 in comparison to 48% in 2003 involved young passenger transport at all hours of the day. Williams et al. reported that the analyses show no effect of night time restrictions on fatal crash involvements. This was the case even when only the 25 states that added night time restrictions between 1993 and 2003 were considered. These results indicate that peer passenger restrictions may be more effective than night time restrictions.

Morrisey et al. (2006) reviewed the FARS for the years 1992-2002. Using binomial regression the study analysed the crash reduction effectiveness of 'good', 'fair', 'marginal', and 'poor' GLS. The results showed that the effectiveness of 'good' GLS were statistically significant with young driver fatalities estimated to be reduced by 19%, whereas the results for the GLS categorised as 'fair', 'marginal', and 'poor' were not statistically significant. The analysis also isolated the effectiveness of peer passenger restrictions. The results indicate that there were only very small reductions in fatalities for young drivers when peer passengers were present, however, reductions in fatalities among peer passengers of up to 35% were revealed for GLS categorised as

'good'. Morrisey et al. concluded that the restriction on the number of passengers does not appear to be effective in reducing young driver fatalities but has reduced fatalities of teenage passengers. In noting that marginal programs were able to reduce teen passenger fatalities, the passenger restriction arguably put fewer teens at risk of a fatal crash rather than significantly reducing the distraction factor associated with passengers in the vehicle. Morrissey et al. pointed out several limitations of the study which relate to the other national studies. Firstly, that GLS programs are relatively new, with programs rated as 'good' being particularly new, which could affect the statistical reliability of the findings. Secondly that enforcement across the states included in the analyses was not controlled for. Thirdly, the analysis included all fatalities, not just at-fault crashes. Therefore, it is likely that some crashes were caused by drivers aged 25 years or older. Finally, the study only focussed on fatalities and not injuries.

These limitations as described by Morrisey et al. (2006) should be taken into consideration when examining the likely effectiveness of GLS in Australia. There are still issues that require consideration such as enforcement and compliance. Within the context of the current evaluation, it is important to note that the studies reported here are all evaluating a peer passenger restriction that lasts for 24 hours. That is novice drivers are unable to carry peer passengers at any time, unless supervised. The peer passenger restriction in the Queensland GLS lasts for 6 hours (from 11pm until 5 am).

The early GLS reviews by Senserrick and Whelan (2003) and Hartling et al. (2004) provided mixed conclusions regarding the effectiveness of peer passenger restrictions. Several evaluations have been conducted since then and while there are some studies that do not demonstrate clear results regarding the effectiveness of the peer passenger restriction, the majority of published studies report positive findings. Indeed some indicate that peer passenger restrictions are more effective than night time driving restrictions. Furthermore, the results of focus groups with various transport groups, educational professionals, parents and teenagers indicate that there is a general level of support for peer passenger restrictions (Raymond et al., 2007). In summary, whilst it appears that the peer passenger restriction may be an effective component of many of the GLS evaluated, the current study will investigate the effectiveness of the peer passenger restriction implemented in the Queensland GLS.

2.5.10 High-powered vehicle restriction

Queensland introduced a high-powered vehicle restriction for all P1 and P2 licence holders. The restriction applies to the following vehicles:

- a vehicle with eight or more cylinders;
- a turbo-charged or super-charged engine that is not diesel powered;
- an engine that has a power output of more than 200 kW (increasing to 210 kW in December 2011) as per the manufacturer's specifications,
- a rotary engine that has an engine capacity of more than 1146cc as per the manufacturer's specifications; and
- a vehicle that has a modification to the engine that needs to be approved.

There are exemptions, including those for some engines that are modified, specific vehicle models, if the vehicle was owned by the young driver for a set period of time prior to the introduction of the law, and for driving to employment, education and hardship reasons.

The aim of the high-powered vehicle restriction is to reduce exposure to risk related to access to a vehicle that facilitates or encourages frequent exposure to high risk driving situations. There is, however, little evidence to support the safety benefits of high performance vehicle restrictions for novice drivers. Following the introduction of this restriction in the state of Victoria (Australia), some initial analysis of Victorian data suggested there had been little potential safety gain from this measure (Drummond, 1994). A Western Australian case-control study of young drivers and the risk of high performance vehicles found no evidence of potential safety gains, although the analysis was severely hindered by an particularly poor response rate of only 7% amongst the controls (Palamara and Gavin, 2005).

A recent study has addressed this gap in the literature by studying New Zealand linked crash and licensing data (Keall and Newstead, 2011). New Zealand presents a suitable laboratory for studying this aspect of vehicle safety as it has a well-established GLS, but without any high performance vehicle restrictions. This study analysed the risk of high performance vehicles compared to other vehicles, focusing on drivers aged under 25. It estimated that the risk of crash-involvement for restricted vehicles was 1.69 times the risk of all other vehicles for under-25-year-olds, and that the injury rate was 2.01 (Keall and Newstead, 2011).

2.5.11 Educational and communication initiatives for novice drivers and parents

The new GLS included a media pack and educational initiatives designed to inform young drivers and their parents of the requirements and restrictions of the GLS. Such initiatives are not considered to be at the core of the theoretical underpinnings of GLS as set out by NHTSA (1998). However they are an important aspect of the GLS in terms of ensuring that both young drivers and their parents are aware of the requirements and restrictions of the GLS. No specific evaluation was found for these initiatives.

2.5.12 Mandating night time restriction when licence disqualified, suspended or the person is subject to a Good Driving Behaviour period

The new GLS imposes a night time driving restriction for young drivers who are returning from a licence suspension or disqualification, or who are subject to a Good Driving Behaviour period. This restriction affects only a small proportion of newly licensed drivers in Queensland. This initiative has theoretical support based on the aims of GLS as described by NHTSA (1998). Several evaluations of a night time driving restriction have been carried out but these evaluations assess a general night time restriction which applies to all novice drivers and not just those who have their licence disqualified or suspended. Police infringement data will allow the number of drivers affected by this restriction to be calculated.

2.5.13 Requiring hazard perception test to enter P2 phase

The new GLS introduced a hazard perception test. The test assesses whether hazard perception skills are sufficiently advanced to progress from a P1 licence to either a P2 or open licence. This test is aimed at assessing an important driver-related cognitive skill, which is essential for safe driving (Senserrick & Whelan, 2003).

The Senserrick and Whelan (2003) review indicated that an evaluation of the Victorian Hazard Perception Test, which was introduced in 1990, indicated that novices with very low scores had higher crash involvement than novices with average and high

scores, despite its very low psychometric reliability (Congdon, 1999 as cited in Senserrick & Whelan, 2003). Low psychometric reliability was considered to be due to the relatively short item duration and to some items eliciting responses that were inconsistent with the responses to other items. There have been no other evaluations to date.

2.5.14 Summary of effectiveness of GLS components

Generally, the thirteen components that were introduced as a part of the new GLS are consistent with the theoretical underpinnings of GLS as set out by NHTSA (1998). Some of the GLS initiatives have been specifically evaluated and for those that had not been specifically evaluated there was generally non-GLS research evidence to support their introduction. During the process of collating and assessing the available literature it became apparent that documenting the effectiveness of the thirteen initiatives was more difficult than expected due to a lack of research. On the other hand, there were many publications of evaluations reporting overall effectiveness of GLS. These publications provided insight into the optimal experimental design for evaluating a GLS. The review of these general evaluations was an important step in developing the methodological design for the current evaluation. As such, the review of overall evaluations is summarised in tabular format below.

2.6 SUMMARY OF METHODOLOGIES AND ISSUES INHERENT IN GLS EVALUATIONS

A key aim of this review is to inform the methodology for the current study through existing research. Comparing results across studies, and also in relation to the current study is quite difficult due to the existence of several methodological issues. These methodological issues are complex, but it is argued that they can be encapsulated by one underlying issue; there is much variability in the results of GLS evaluations and as a result, it is difficult to accurately compare results of evaluations across studies and jurisdictions. This variability is attributed to three factors. The first is that no two GLS implementations are the same, in terms of GLS components incorporated. There is also significant variation in the non-GLS factors in play between jurisdictions potentially confounding the results, for example level of enforcement, driving patterns, or demographic factors. Secondly, the experimental design and resulting statistical methods applied to evaluate GLS are often different. Thirdly, evaluations are often limited by the quality of the data available for the analysis. The data that is used in GLS evaluations is often routinely collected crash data, but this data may not be designed to address the issues being examined in the GLS evaluation. For example, in some cases the age of the passengers is only recorded if they are injured in a crash, which inhibits the ability to determine the effectiveness of a peer passenger restriction. In summary, the variability in findings of GLS evaluations is due to the variation in GLS implementations and parallel road safety programs across jurisdictions, variability in experimental approaches adopted and data available when evaluating GLS implementations. As a result it is almost impossible to compare studies and understand whether the findings are due to the methodology adopted or the licensing components included in that particular GLS.

Hartling et al. (2004) argued that a standard approach would allow for comparisons to be made across evaluations. Hartling et al. argued that "presently there are few validated instruments available for the assessment of methodological quality of observational studies and none to our best knowledge that specifically address

ecological studies. In order to synthesize available evidence and interpret it in a judicious manner, there is a need to develop a valid tool to assess quality of different types of observational studies." (Hartling et al., 2004, pp. 10). Hartling et al. reported that some GLS restrictions vary across jurisdictions within key elements (e.g. the hours of restriction under a night time driving restriction) despite the research evidence suggesting the exact nature of these key elements (e.g. that a night time driving restriction should commence before midnight). This standardised approach would be beneficial for researchers and policy makers as it would allow comparison across otherwise different licensing systems. If the effectiveness of systems with different restrictions could be compared then this would arguably contribute to the understanding of the effectiveness of specific components. At the moment, it is not possible to attribute GLS effectiveness to components or methodological approach.

Despite the difficulties in understanding how the GLS itself and methodologies used to evaluate GLS contribute to the overall evaluation findings, in the past decade the discussions of research findings and conferences dedicated to GLS have all contributed to the overall improvement in the knowledge about GLS. A consensus on the exact restrictions and requirements that constitute an effective GLS is forming amongst the research community and the statistical techniques adopted for evaluating GLS are becoming standardised. Indeed several approaches have been proposed that aim to standardise the GLS implementations across jurisdictions (Mayhew, Simpson & Singhal, 2005) particularly in North America. Hartling et al. argued that adopting a standardised methodological approach to evaluate GLS also would allow for comparisons across GLS evaluations (2004).

Table 3 summarises the methodologies and study designs used to evaluate GLS since 2004. It is clear that there are fundamental differences between the GLS in each jurisdiction in comparison to the GLS that exist in Australia and in particular in Queensland. Despite these differences, the young driver problem and resulting research questions are the same. Therefore, the study design, and statistical techniques could be, in theory, similar. The following section aims to elaborate on the information presented in Table 3 and gain an understanding of future directions for best-practice experimental design for GLS evaluations.

Table 3: Summary of experimental designs and methodologies from previous GLS evaluations

Jurisdiction	Methods	Participants	Interventions	Outcomes	Statistical Methods	Data Source	Denominator
Oregon Mayhew et al. (2006) – GLS evaluation	Ecological study: multiple groups studied over time Years 2002	16-17 year old drivers. No comparison group	Comparison of Oregon and Ontario licensing systems	Analysis of two jurisdictions allowed for comparisons of important licensing components of GLS, such as night time driving restrictions.	Crash rate comparison	Oregon, Microsoft Access Databases of licensing and crash data. 1,878 crashes for 16-year olds, and 2,839 for 17-year olds Ontario- Ontario Accident Database – 2,086 crashes for 16-year olds and 9,230 for 17-year old drivers. Population figures based on 2000 Census.	Crash rate per 1,000 population, and crash rate per 1,000 licensed drivers
Oregon Mayhew et al. (2006) – telephone survey	Ecological study: multiple groups studied over time Years 2004-2005	16-17 year old drivers. Comparison group: British Columbia drivers	Comparison of telephone survey data from sample of Oregon and British Columbia drivers	Analysed telephone survey data of a sample of young drivers who had a collision compared to those that were collision free. Collision involved drivers had more driving errors than collision free. Majority of all drivers across both jurisdictions passed driving test on first attempt.	Binary logistic regression,	Telephone survey of 1,060, and 1,064 young drivers from Oregon and one of their parents in British Columbia and Oregon respectively.	Crash involvement
Oregon Raymond	Ecological study:	16-24 year olds who had received licence	Pre- post-comparison of Oregon GLS	Twenty four data cells for analysis. This is based on initial age at licensure, 1st 6-	Not specified, a mixture of correlation and	Oregon Driver and Motor Vehicle	Crashes per 1,000 drivers

(2007)	Single groups studied over time	from January 1st 1998 to November 2003 Comparison group was drivers not subjected to GLS requirements – those aged 18 who received their licence before GLS was enacted and those aged 25-64 years.	based on convictions, suspensions and crashes.	months, 2nd 6-months and 2nd year of licensure, and when the driver was licensed based on phasing in of GLS. Crash were both at fault and not at fault. Suspension, crash rates were lower after the implementation of the GLS	percentages of crash rates, convictions, and suspensions with some univariate tests of significance.	Services	
California Cooper and Gillan (2005)	Ecological study: Single groups studied over time Years: July 1997 – October 2002	16-year-old drivers	California GLS introduced July 1998. pre- and post-	Three general periods were considered: 1) period prior to change in law; 2) period of adjustment after the law announced and comes into effect; 3) period of the new equilibrium when all adjustments to the new GLS have been internalised. At fault crashes for 16 year-old	Time series, and a new econometric technique developed by Bai and Perron which allows distinguishing between different regimes of behaviour and periods of equilibrium and	State-wide Integrated Traffic Records System	Per 1,000 licensed drivers

				drivers decreased by 11% and the average number of teenage passengers carried by 16 year-old drivers decreased by approximately 31%. Estimated that these results saw a saving of 29 lives and the prevention of 2,632 injuries.	disequilibrium.		
California Masten & Hagge (2004)	Ecological study: Single groups studied over time Years: Jan 1994 – Dec 2001	15- 17-year-olds treatment group 24-55 year olds comparison group	California GLS introduced July 1st 1998. A pre- (January 1994-June 1998) and post- (July 1998 – Dec 2001)	No temporary or permanent change in fatality and injury rate per population for 16 year olds, and analysis on 15-17 year olds. This effect remained when the implementation date was moved 6-months into new GLS period and also 12-months into new GLS period.	Autoregressive integrated moving average (ARIMA) intervention time series analysis	State-wide Integrated Traffic Records System	Per 1,000 population
California Rice et al., (2004)	Ecological study: Single groups studied over time Years: 1997, 2000,	16-17 year olds treatment group 25-34 comparison group	California GLS introduced July 1st 1998.	Fatal or severe injury crash rates reduced from 17–28% and minor injury crash rates reduced 10–13% pre- and post-GLS implementation.	Adjusted rate ratios	State-wide Integrated Traffic Records System All injury severities and fatalities	Per 10,000 population

	2001						
Utah Hyde et al., (2005)	Ecological study Single groups studied over time Years 1996-2001	16-year-old drivers treatment group No comparison group	Utah GLS introduced July 1st 1999 for pre- and post-comparison	Overall crash rate reduced by 5%, and time series analysis indicated that crashes reduced by 0.8 per month per 1,000 licensed driver following GLS implementation	Rate ratios used to examine change in crash types such as night time and peer passengers. Box Jenkins autoregressive integrated moving average (ARIMA) used for overall GLS effectiveness.	Four databases – Utah motor vehicle crash database Utah emergency department database Utah hospital inpatient database Utah driver licence database	Per 1,000 licensed driver
Georgia Kellerman (2007)	Ecological Study multiple groups studied over time Years 1992-2002 5.5 years	16-20-year olds tested separately, and 21-24-year olds tested as group treatment group Comparison group – comparison states of Tennessee, South Carolina	Georgia GLS and Teenaged and Adult Driver Responsibility Act (TADRA) introduced July 1997.	Significant decrease in fatal crashes involving 16-year old drivers and 17-year old drivers. After GLS implemented the crash rate of 16-year old drivers was lower than crash rate of 21-24-year old drivers. Significant reductions in speed-related and alcohol-related crashes for 16-year old drivers. Driving between 3pm-6pm most dangerous for 16-year	Chi-square	Fatality Analysis Reporting System (FARS)	Per 100,000 population

	pre- 5.5 years post-	and Alabama 25+ year olds comparison group, plus 16-year old fatality rate nationwide		olds.			
North Carolina Margolis et al., (2007)	Ecological study: Single group studied over time Years 1996-2001	16-17 year olds treatment group 25-54 year olds comparison group	North Carolina GLS introduced December 1st 1997	Used actual dates of phasing in of GLS – so for 16-year old drivers 1st December 1998, and for 17-year old drivers 1st December 1999. Hospitalisations among 16-year-olds were significantly reduced after the implementation of the GLS. Estimated $650,000 per year in hospital charges have been averted for 16-year-olds. Interpreted as due to reduced exposure not improvement in young drivers	Autoregressive Integrated Moving Average (ARIMA)	Hospitalisation data	Per 100,000 population, monthly hospitalisations per 100,000
Michigan Shoppe & Molnar (2004)	Ecological study Single groups studied over time	16-year-olds	Michigan GLS introduced April 1st 1997	Significant reduction in crashes after implementation of GLS, particularly crashes occurring during night time hours.	Relative risks and 95% CI.	Michigan Police reported crash database.	Crash rates per 1,000 population

	Years 1994-1996 – pre-GLS 1998-2001 – post-GLS						
British Columbia Wiggins (2004)	Ecological study Single groups studied over time Years August 1, 1996 – July 31 1997 (pre-GLS) August 1, 1998 – July 31 1999 (post-GLS)	16-, 17-, 18-, 19-21, 22-24, 25+	British Columbia August 1st 1998	Learner phase primary component contributing to reduction in crashes after GLS implementation.	Relative risks, poison regression, chi-square	Five databases were merged for each driver (pg 37). Driver Licensing System, Driver Training School System, Traffic Accident System, Insurance Corporation of British Columbia Business Information Warehouse Claims.	None specified

Table 3 shows that one methodological variation across evaluations is the number of years of data included in the analysis overall, and the number of years included for the post-GLS implementation period. According to Hartling et al. (2004), a minimum of three years baseline and follow-up data should be included in the evaluation of GLS. For many GLS this would allow the first full cohort to have completed the GLS and be entering the full licence phase (depending on the length of the phases overall). They argued that studies with short follow-up periods may report findings that are misleading. A common pattern that is observed with the implementation of a new GLS is that there is a rush to be licensed before the new GLS comes into effect. Even though calculating crashes on a per licensed driver basis does control for changes in licensing rates, without a long-term follow-up period patterns in licensing and crash rates are not able to become stabilised, hence affecting the evaluation of the full impact of the program. It is argued that assessing the minimum amount of data required, that is, conducting a sample size analysis, could provide support for Hartling et al's estimation of 3-years minimum baseline and follow-up. Although there were some studies where the follow-up period was less than three years the majority of studies in Table 3 report follow-up periods of 3-years or more.

All studies reported in Table 3 were considered to be ecological. The majority were single groups studied over time. According to Morgenstern (1995, as cited in Hingson et al., 2001), ecological studies are where groups, rather than individuals, are the units of analysis. The groups are generally resident populations of geopolitical areas such as states or counties. Ecological studies are able to detect individual exposures that affect risk to others. That is, when people are injured because of the behaviour of others – for example, injuries to others caused by speeding drivers. According to Hingson et al., where individual-level associations might not detect important spill over effects, ecological studies may detect them. Hingson et al. discuss the adoption of ecological methodologies to the state-based level whereby the effectiveness of laws is assessed. Hingson et al. used speed limits, safety belt and child restraint laws, and drink driving legislation as examples for study of group-level exposures. He states that evaluation of these interventions may involve "determining whether the presence of the law, policy, or program in a population is associated with a lower rate of adverse outcomes in that population" (Hingson et al., 2001, pp. 159). Clearly such studies are closely related to GLS evaluations that assess injury rates as an indicator of adverse outcomes.

Hingson et al. (2001), point out that adopting ecologic study designs to evaluate laws and policies is a very important application of this study design, due to the attractiveness of legal intervention as a strategy for injury control. For example, studies have indicated that following the implementation of a GLS law for young drivers that prohibits the carrying of peer passengers, crashes involving peer passengers has decreased. Hingson et al. point out that the deterrent effect of the law may reduce the likelihood of engaging in the behaviour (i.e. driving with peer passengers) and the likelihood of continuing to engage in this behaviour following detection for non-compliance. Hingson et al. also point out that public debate prior to enacting the law and in the lead up to the law coming into effect can increase public awareness, educate the public regarding the risky behaviour, and provide justification for making the behaviour illegal.

The study by Cooper and Gillan (2004) was unique in that it defined pre- and post-GLS implementation periods using three categories, instead of two categories. These were the period prior to the change in the law, then the period of adjustment after the law is announced and comes into effect and finally the period of the new equilibrium when all

adjustments to the new GLS have been internalised. The first and third categories are the standard pre- and post-GLS implementation. It is the second category that takes into account behaviour change prior to the new GLS being implemented. Therefore, Cooper and Gillan have acknowledged that even before the new GLS has been implemented that there is potential for behaviour change based on the knowledge that the law will change and public debate surrounding law. Most of the other GLS evaluations defined the post-GLS implementation period as the date of the new GLS being introduced. Potentially the post-GLS implementation period could be defined earlier, or evaluations could include a third period that takes into account the date of announcement that the law will be introduced.

Table 3 shows a relatively large range of data sources used across evaluations. Many of the evaluations used state-based crash databases. Often the description of data sources was scarce. Furthermore a clear definition of the crash types and injury severities used was also scarce.

The age of drivers in the evaluations that constituted the young driver group varied widely. For the young driver group, evaluations involved either grouping those in their first two years of the intermediate licence, or only using data from 16-year-old drivers, or separately comparing 16-year-olds, 17-year-olds, and 18-year-olds, and comparing those with experienced drivers (whose definition varied widely also). For the experienced driver group, which often served as the comparison group, drivers were generally defined as those aged 25-years or older. Comparison groups are an important element of the experimental design of GLS evaluations. Simpson (2003) pointed out that GLS evaluations that do not include a comparison group are not able to account for the effects of other factors related to crash risk. There were only a few studies reported in Table 3 that did not include a comparison group, for example Hyde et al. (2005) and Mayhew et al (2006). Thompson and Sacks (2001) point out that while there are several methodological approaches to evaluative research, well-designed case-control studies are an important element of program evaluations.

The statistical techniques used were generally either a form of regression, rate ratios, and to a lesser extent chi-square and t-tests. Hartling et al. (2004) pointed out that those studies using time series analyses were generally more conservative than studies using other statistical methods. It is argued that the evaluation of a GLS is a complex process. The statistical technique must be able to account for seasonal fluctuations. As such, regression techniques are considered to be optimal for GLS evaluations.

Another area where the studies differ is the denominator used to assess crash rates. Generally rates per population or licensed driver were used. According to Imai and Mansfield (2008), using population as the denominator greatly underestimates the vulnerability of young drivers. They point out that the licensed driver fatality rate is 300% higher than the population rate of 16-year old drivers. The differences in fatality rates for young adults narrow as age increases, but the measures do no approximate equivalence until 24-years-old. These statistics indicate that the per-licensed driver data is the optimal choice. An understanding of the proportion of unlicensed young driver fatalities is important here.

It is interesting to note that some studies reported many data cells for comparison indicating that the GLS was phased in over time dependent on age at the time of the new restrictions being implemented. This has direct relevance for the current review as there are several groups moving through the Queensland GLS at the one time,

dependent on their age at the time of July 1st 2007 and their licensing stage. Raymond et al. (2007) reported that there were 24 data cells in the evaluation of the Oregon GLS due to the phasing in of restrictions based on age and time of gaining licence. It is argued that the study design of Raymond et al. (2007) is not very strong based on the statistical techniques used, however the classification of 24 data cells is a study design element that should be taken into account in the design of the current study.

In summary, the review of the methodologies of GLS evaluations post-2004 has provided insight into which elements of experimental design are consistent across studies and which elements tend to vary. In addition, the review has provided a preliminary grounding for best-practice GLS evaluation methodology. All study designs were considered to be ecological, with either multiple or single groups studied over time. The benefits of ecological study designs were outlined by Hingson et al. (2001). Hartling et al. (2004) recommended at least 3 years of post-GLS implementation data be incorporated into an evaluation. It is argued that a power analysis of sample size be carried out prior to the Queensland GLS evaluation. It is argued that data analysis should compare approaches to defining pre- and post-periods to investigate any differences. For example, defining pre- post- the standard way of before and after the GLS implementation date, in comparison to the pre-GLS announcement data, post-GLS announcement and post-GLS introduction. This latter approach was taken by Copper and Gillan (2004) and it aims to take into account potential for behaviour change following the announcement of the law change. The sources of data were generally from state-based crash database. Often there was a lack of information regarding the type of data contained in these crash databases. It is argued that a clear description of the data sources utilised is necessary. A form of regression that can control for crash rate fluctuations should be considered the standard statistical technique for GLS evaluations. The inclusion of a comparison group is an essential element of the experimental design to account for non-GLS crash effects (e.g. other road safety initiatives such as enforcement operations, or socio-economic factors). The literature indicates that the optimum denominator is per licensed drivers; however a clear understanding of the proportion of the unlicensed young driver fatality rate is important before ruling out population based denominators.

3 PRIMARY EVALUATION: METHOD

3.1 AIMS AND EVALUATION METHODOLOGY OVERVIEW

The Primary Evaluation aims to compare the police-reported crash rates for drivers before and after implementation of the new GLS relative to a comparison group of drivers on their Open licence using three levels of analyses:

1. **Overall assessment of the GLS**: Estimates the overall changes in crash rates associated with the new GLS. This level of analysis comprises:

1.1 Overall program including old GLS: overall program effects of the new GLS (L, P1, P2, Open) including some drivers that were licensed on their Ls and Ps on the old GLS (L (old), P, Open (old))

1.2 Overall program only new GLS: Overall program effects of the new GLS including those licensed fully or partly under the new GLS (L, L (old), P1, P2, Open) but excluding those licensed under the old GLS that are still on the L or P phase after the new GLS implementation

2. **Assessment of new GLS by licence type:** Estimates changes in crash rates associated with the new GLS by licence level (L, P1, P2 and Open)
3. **Assessment of the new GLS by pre-defined treatment groups (i.e. TG 1-6 vs. TG7-10):** Estimates changes in crash rates associated with the new GLS by the various pathways by which drivers can progress through the GLS (as defined in Section 3.2). All drivers licensed fully under the new GLS (Treatment Groups 1-6) are compared to those licensed under both new and old GLS (Treatment Groups 7-10)
4. **Assessment of the new GLS by Treatment Group 1:** Estimates changes in crash rates associated with the new GLS for drivers in Treatment Group 1 (as defined in Section 3.2) who progress through all licence phases of the new GLS. Treatment Group 1 comprises the majority of drivers progressing through the GLS because they tend to commence each licence phase at the minimum entry age - for example, they obtain their Learner licence within a few months of turning 16 and progress to P1 around the age of 17 etc.

To undertake the four levels of analysis as described above there were three key steps in the evaluation methodology. The first two relate to defining the treatment/comparison groups, and preparation of licensing/crash data. The final step relates to conceptualising the experimental design. These steps are depicted in Figure 2 and discussed in Sections 3.2-3.5 respectively.

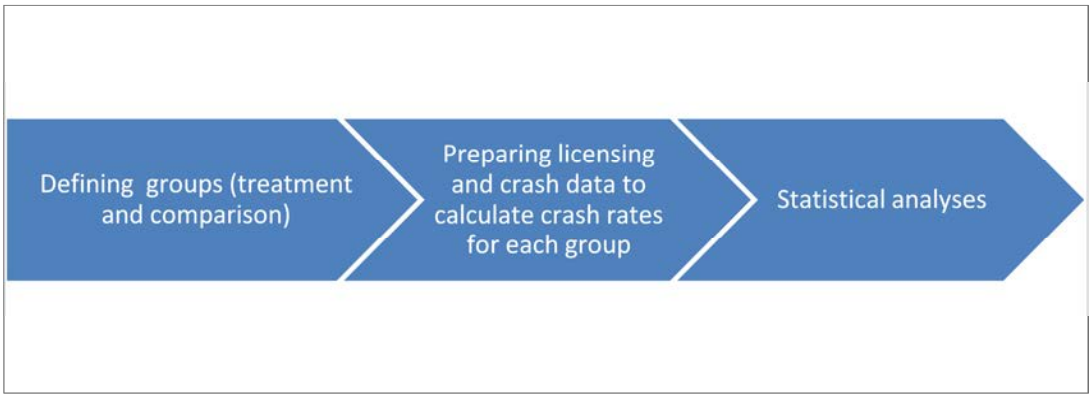


Figure 2: Key steps in evaluation methodology

3.2 DEFINING TREATMENT AND COMPARISON GROUPS

3.2.1 Treatment Groups

The first step in developing the experimental design to evaluate the new GLS was to understand the requirements/restrictions on each licence phase, the age-based exemptions that existed for the new GLS, and, which conditions enabled drivers to enter the GLS on the old GLS and exit on the new GLS. This process revealed that the progression of phases on the new GLS and requirements/restrictions within each phase vary depending on a driver's age at the time of licensing and the time period in which they were licensed (i.e. entirely on the new GLS versus both the old and new GLS). These variations were translated into ten treatment groups which are described in Table 4 and Table 5. The treatment groups were used in the final level of analysis as described in Section 3.1.

Each of the ten treatment groups defined in Table 4 cover drivers that were subject to the new GLS licensing conditions during some phase of their licensing progression (L, P1 or P2 phases). In addition, those who were licensed under the old GLS constitute the treatment group for the period before the introduction of the New GLS; these are drivers who obtained their Learner and/or Provisional licence under the old-GLS. This group is considered the 'before group' in the comparison of crash rates before and after the new GLS implementation, and are therefore a critical group of drivers in the experimental design.

Table 4: Description and Progression of Treatment Groups Based on Licensing Age

	Description of defining characteristics of each group
1	Licence activity new GLS; obtained Ls aged under 22; P1 under 23; P2 under 25;
2	Licence activity new GLS; obtained Ls aged under 23; P1 aged 23; P2 between 24-25; age-based exemptions P2 hold 1 year only
3	Licence activity new GLS; obtained Ls aged under 24; P1 aged 24; age-based exemptions no P2 phase
4	Licence activity new GLS; obtained Ls aged under 25 years; P2 aged 25 years; age-based exemptions no P1 phase; age-based exemptions on the P2 period: only hold P2 for 1 year, exempt from the HPV restriction, and late night driving restriction as penalty for exceeding demerit point threshold
5	Licence activity new GLS; obtained Ls aged 25 years or over; P2 aged 25 years or above age-based exemptions no P1 phase; age-based exemptions on the Learner period: logbook is voluntary and no mobile phone restriction P2 period: only hold P2 for 1 year, exempt from the HPV restriction, and late night driving restriction as penalty for exceeding demerit point threshold.
6	Licence activity new GLS; obtained Ls but have no progressed beyond this licence phase
7	Licence activity old and new GLS; Learners on old system aged 16.5 – 23 years; P1 aged under 23 years; P2 under 25 In new GLS subject to the same requirements and restrictions as drivers in Treatment Group 1
8	Licence activity old and new GLS; Learners on old system aged 16.5 – 24 years; P1 aged 24 years; aged-based exemptions no P2 phase In new GLS period are therefore subject to the same requirements and restrictions as Treatment Group 3
9	Licence activity old and new GLS; Learners on old system aged 16.5+; P2 aged 25 years or above; age-based exemptions no P1 phase; age-based exemptions on the P2 period: only hold P2 for 1 year, exempt from the HPV restriction, and late night driving restriction as penalty for exceeding demerit point threshold. In new GLS period are therefore subject to the same requirements and restrictions as Treatment Group 4
10	Licence activity old GLS; obtained Ls but have no progressed beyond this licence phase

Table 5: Description of Progression of New GLS Treatment Groups (TG) Based on Licensing Age

TG	L (Old GLS)	L (New GLS)	P1	P2
1		12-month minimum holding period; L plates; Logbook supervised 100 hours; Mobile phone restriction; Zero BAC	12-month minimum holding period; Red P plates; Peer passenger restriction; Mobile phone restriction; High powered vehicle restriction; Zero BAC; Late night driving restriction as penalty for accumulating 4+ demerit points; HPT to progress to next phase	24-month holding period; High powered vehicle restriction; Zero BAC; Late night driving restriction as penalty for accumulating 4+ demerit points
2		As above	As above	As above except 12-month holding period
3		As above	As above	No P2; HPT to progress to Open
4		As above	No P1	12-month holding period
5		Logbook supervised 100 hours voluntary; Zero BAC	No P1	12-month holding period
6*		See footnote	N/A	N/A
7	Minimum 6-month holding period; No requirement to display L plates; No log book; Zero BAC		As per Treatment Group 1	As per Treatment Group 1
8	As above		As per Treatment Group 3	As per Treatment Group 3
9	As above		As per Treatment Group 4	As per Treatment Group 4
10*	As above		N/A	N/A

*Treatment Group 6 and Treatment Group 10 include those that have obtained a Learner Licence only, and have not progressed beyond this point hence it is not possible to identify at the time of evaluation which of the other groups they will ultimately belong to.

3.2.2 Comparison Group

In order to control for confounding factors affecting novice driver crash risk other than the introduction of the new GLS, a comparison group, sometimes referred to as a control group, was defined for use in the evaluation. The comparison group was defined as Open licensed car drivers aged between 25-35 years. This group have been devised to purposefully share similarity to the treatment groups in age, and to have completed their progression through the GLS. The comparison group represents the time based changes in broad crash risk for all non-GLS related road safety initiatives in Queensland occurring during the study period. These broad factors potentially affecting crash risk across all drivers in Queensland include the introduction of road-side drug testing, and increased number of speed cameras. A list of all non-GLS initiatives that were introduced around the time of the new GLS implementation can be found in APPENDIX A. The comparison group can also represent the influence of non-road safety program related factors on crash risk such as changes in travel, socio-economic influences such as unemployment rate as well as environmental influences such as weather.

3.3 PREPARING LICENSING AND CRASH DATA TO CALCULATE CRASH RATES FOR TREATMENT AND COMPARISON GROUPS

3.3.1 Driver licensing data specifications

The licence data was extracted from the TMR TRAILS database for the period November 1986 – November 2011. This twenty-five year time period enabled the extraction of:

1. The comparison group: drivers aged 25-35 during the period July 2004 – November 2011 and holding an open licence during that time;
2. The old GLS treatment group: drivers entering the old GLS from July 2004 until June 2007; and
3. The new GLS treatment group: drivers entering the new GLS from July 2007 until November 2011.

The licence data consisted of the driver's:

- birth date
- de-identified (surrogate) customer reference number (used for data linking);
- an indicator for interstate or overseas transfer (i.e. driver held a licence in another state or country and transferred this to Queensland);
- information on each licensing event for each individual (a licensing event being any change in licence type or class) including:
    - start and end date;
    - licence type (e.g. L, P1, P2, Open);
    - licence class (e.g. car, motorcycle, heavy vehicle using codes such as C, RE, HR to denote licence class and specific conditions. For example, "C" denotes light passenger vehicle.

3.3.2 Driver licensing data preparation

The licensing data was prepared to identify each of the groups of drivers (pre and post treatment and comparison group) and to extract each group's exposure data (outlined below).

To minimise bias two inclusion criteria were applied to the data before identifying the groups. Licence records were only included in the identification of groups if:

1. The individual held a car licence (i.e. C or CA class) - as opposed to holders of only a motorcycle or heavy rigid truck licence for example;
2. The individual did not have an interstate or overseas transfer indicator - ensuring that all drivers had been licensed originally under the Queensland licensing system and therefore had not received any concessions for transferring

The task of identifying the treatment groups was completed using the information in Table 4 and by calculating the following additional variables:

1. Four variables labelled '*Age When Driver Obtained Ls/P1/P2/Open Licence'* were calculated by subtracting the driver's licence start date from their birth date for each of the four licence types
2. A variable labelled '*New GLS Date'* was calculated as 1 July 2007 for all licence records. '*New GLS Date'* was used as a reference date to denote the start of the new GLS period, therefore any start dates for driver's licence activity before the GLS was under the old GLS

Using these variables and the information in Table 4 the new GLS treatment groups were identified in SPSS statistical analysis software. For example, drivers were assigned to Treatment Group 1 if they obtained their Ls on or after the *'New GLS Date'* and their '*Age When Driver Obtained Ls'* was less than 22 and their *'Age When Driver Obtained P1'* was less than 23 and their '*Age When Driver Obtained P2'* was less than 25.

Drivers were assigned to the Pre Treatment Group (comprising drivers solely under the old GLS) if they obtained a Learner licence in the old GLS period and progressed to a P licence (as opposed to progressing to a P1 or P2 licence). Two further variables were calculated for the old GLS treatment group labelled '*First Year on P Licence*' and '*Second and Subsequent Years on P Licence'*. These variables were calculated so that the P-plate phase on the old GLS could be compared to the P1 and P2 phases on the new GLS. The start date for the '*First Year on P Licence*' was the start date of the driver obtaining their P-plate licence and the start date for '*Second and Subsequent Years on P Licence'* was calculated by adding 366 days to the start date of obtaining the P-plate licence. This classification method might be inaccurate for those who let their Provisional licence lapse or who are suspended but these people represent a very small proportion of the total driver population.

The comparison group was identified by calculating the date when each driver would reach 25 and 35 years of age in conjunction with the start date of the open licence. Using these three variables (*'25th Birthday' '35th Birthday'* and *'Open licence start date')* the period when a driver entered the comparison group was calculated.

3.3.3 Driver licensing data calculation of person months of licence exposure

After preparing the licensing data and categorising drivers into the three groups, the licence exposure was calculated running frequency tables in SPSS for each group by start dates (in *month/year* format) as summarised in Table 6 and depicted as an example in Table 7.

Table 6: Variables used to extract data for the calculation of person months of exposure for each group

Crosstab #	Crosstab description (i.e. Group *by* Licence phase)
1	For new GLS Treatment Groups 1-10 *by* date (in *mmm yyyy* format) that the driver obtained Ls
2	For new GLS Treatment Groups 1-10 *by* date (in *mmm yyyy* format) that the driver obtained P1 licence
3	For new GLS Treatment Groups 1-10 *by* date (in *mmm yyyy* format) that the driver obtained P2 licence
4	For new GLS Treatment Groups 1-10 *by* date (in *mmm yyyy* format) that the driver obtained Open licence
5	Old GLS treatment group *by* date (in *mmm yyyy* format) that the driver obtained Ls
6	Old GLS treatment group *by* date (in *mmm yyyy* format) that the driver obtained P First Year
7	Old GLS treatment group *by* date (in *mmm yyyy* format) that the driver obtained P Second and Subsequent Years
8	Old GLS treatment group *by* date (in *mmm yyyy* format) that the driver obtained Open licence
9	Comparison group *by* date (in *mmm yyyy* format) when driver entered the comparison group
10	Comparison group *by* date (in *mmm yyyy* format) when driver entered exited the comparison group

Table 7: Example of 12-months of raw exposure data for frequency Table 9 – Comparison group *by* date (in *mmm yyyy* format) when driver entered the comparison group

Date when entered comparison group	Count
JUL 2004	3730
AUG 2004	3784
SEP 2004	3725
OCT 2004	3717
NOV 2004	3572
DEC 2004	3554
JAN 2005	3687
FEB 2005	3609
MAR 2005	4029
APR 2005	3701
MAY 2005	3882
JUN 2005	3938
JUL 2005	3390

As per the example displayed in Table 7 and the description of the crosstabs in Table 6, the crosstabs provided a monthly count between July 2004 – November 2011 for each group of drivers entering each licence phase (for treatment and comparison groups), and, for the comparison group a count for drivers entering and exiting the comparison group period.

The raw data generated from these crosstabs were exported to Microsoft Excel in preparation for the calculation of person months of licence exposure by creating separate sheets for each group. For each separate new GLS treatment group the data generated from crosstabs 1-4 were used to create a single sheet per treatment group to display the number of drivers entering the Learner, P1, P2, and Open phases by month/year. The data generated from crosstabs 5 – 8 were similarly used to create an old GLS treatment group sheet which displayed the number of drivers entering the Learner, P First year, P Second and Subsequent Years, and Open licence phases. The data generated from crosstabs 9 and 10 were used to display the number of drivers entering and exiting the comparison group each month.

Using these separate sheets for each group the person months of licence exposure was calculated as follows:

New GLS Treatment groups: *Person months of licence exposure per month = [(total number of licence holders in previous month) + (1/2 of the new or age relevant licence holders in current month)] - (½ of the licence holders in current month who went onto the next licensing phase e.g. P1 or P2 or Open).*

Old GLS Treatment group: *Person months of licence exposure per month = [(total number of licence holders in previous month) + (1/2 of the new or age relevant licence holders in current month)] - (½ of the licence holders in current month who went onto the next licensing phase e.g. P First Year or P Second and Subsequent Years or Open).*

Comparison group: *Person months of licence exposure per month = [(total number of licence holders in previous month) + (1/2 of the new comparison group drivers entering in current month)] - (½ of the comparison group drivers in current month who exited the comparison group phase)).*

The formula reflects that those who enter or leave a category during a month will on average only be exposed in that category for half the month assuming a uniform transfer rate over time. This assumes that licences are issued uniformly over the days of the month which is likely to be true given the finite capacity for licence testing in the licensing system. For example for Treatment Group 1 the following exposure measure was estimated for July 2008:

During July 2008 there were 4,603 new Learner licences issued to drivers aged less than 25 years, and there were 2,160 Learners who went onto their P1 licence during that month. The total number of Learner licence holders in the previous month (June 2008) was 45,253.

Hence the person months of licence exposure for Learner drivers in July 2008 was estimated as:

Person licence months of exposure = 45,253 + (½ x 4,603) – (½ x 2,160) = 44,405.5.

The person licence months of licence exposure was therefore calculated for each month between July 2004 and November 2011 and each licensing phase for each group (as described in Table 6) and this data formed the denominator for the calculation of crash rates which are discussed in subsequent sections following the description and preparation of the police-reported crash data.

3.3.4 Police-reported crash data specifications

All police-reported crashes in Queensland from January 2004 onwards were extracted from the TMR crash database. The key variables used in the crash data were '*Crash Severity'* and '*Crash Date'*. '*Crash Severity'* was provided in five levels, in order of seriousness:

- Fatal – a crash from which at least one person was killed;
- Serious Injury – a crash from which at least one person was admitted to hospital but no-one was killed;
- Medical Treatment – a crash from which at least one person was injured requiring medical treatment but no one was killed or seriously injured;
- Minor Injury - a crash from which at least one person sustained a minor injury but no one was killed or seriously injured or had a medically treated injury
- Non-Injury – A crash from which no one was injured.

The period for which data was extracted was from July 2004 until the maximum date for which data was available for each level of crash severity. This resulted in the following start and end dates for data extraction:

- July 2004 – December 2009 for police-reported crashes of all severity
- July 2004 – December 2010 for hospitalisation police-reported crashes
- July 2004 – November 2011 for fatal police-reported crashes

3.3.5 Police-reported crash data preparation

The prepared licensing data (see Section 3.3.2) was merged to the police-reported crash data using the data linkage variable of 'customer reference number' (which was de-identified from original customer reference number). Additional variables were then calculated in order to allocate crashes to licence phases for each group and this resulted in variables with the following labels: *'Crash Date During Ls', 'Crash Date During P1', 'Crash Date During P2', 'Crash Date During Open', 'Crash Date During P First Year'* and *'Crash Date During P Second and Subsequent Years'*. It was necessary to calculate these variables so that the crash counts for each licence level in each of the treatment and comparison groups for each month from July 2004 to November 2011 could be extracted and used to calculate crash rates. These variables were calculated by assigning the crash to a licence level if the crash date was within the start and end date of that licence level. For example to calculate *'Crash Date During P1'* a syntax in SPSS was executed which assigned the driver's crash date to the P1 period if: *crash date is greater than or equal to the start date of obtaining P1 AND the crash date is less than the start date of obtaining P2.*

Similar to the crosstabs as described in Table 6 crosstabs in SPSS were calculated for each group for the relevant variables: '*Crash Date During Ls', 'Crash Date During P1', 'Crash Date During P2', 'Crash Date During Open', 'Crash Date During P First Year'* and *'Crash Date During P Second and Subsequent Years'*. For example, for each treatment group the following four frequency tables were calculated: *'Crash Date During Ls', 'Crash Date During P1', 'Crash Date During P2'*, and *'Crash Date During Open'*.

The raw data generated were exported to Microsoft Excel in preparation for the calculation of crash rates. The crashes per month were added to the person months of licence exposure sheets for each group.

3.3.6 Crash rate data periods and calculation method

The crash rate data was calculated for each month for each licence level that was relevant to each group from July 2004 to the maximum date for which data was available for each level of crash severity. The comparison of crash rates for drivers under the old and new GLS relative to the comparison group is the foundation of the Primary Evaluation. Those licensed under the old GLS were considered to be in the pre-period and those under the new GLS the post-period with the comparison group spanning both pre- and post-periods.

The pre- and post-periods for which crash rates were calculated were as follows:

Pre-period - July 2004 to June 2007

Post-period (crash rate all severities) - July 2007- December 2009

Post-period (crash rate hospitalisation crashes) - July 2007 – December 2010

Post-period (crash rate fatal crashes) - July 2007 – November 2011

For each group the crash rates per 10,000 licence months of exposure were calculated as follows:

Crash rate per month = 10,000 x (monthly crash frequency) / (person months of licence exposure).

3.4 ANALYSIS DESIGN

In summary the first two steps of the methodology involved defining the treatment and comparison groups, preparing the licensing data to calculate person months of licence exposure, preparing the crash data to calculate monthly crash frequency, and using the exposure and crash count data to calculate the crash rates for each group. The crash rate in the post-period was broken into three categories due to the different end dates for availability of crash for various crash severities.

The primary evaluation fundamental analysis design was quasi-experimental. As described in Section 3.2 the analysis estimated changes in crash rates associated with each licence level in the analysis periods from before to after implementation of the new GLS relative to changes in crash rates in the comparison group over the same time period. As noted in Section 3.2.2, the comparison group has been defined to represent changes in all other factors other than the new GLS influencing crash risk in Queensland over the study period. Comparing changes in the crash risk of the GLS treatment groups from before to after new GLS implementation with parallel changes in the comparison group gives the net crash effect associated with the GLS controlled for all other factors represented in the comparison group.

Implementation of the GLS in Queensland meant the analysis design had a degree of complexity above that typically found in a simple quasi-experiment. First, the treatment groups had to be stratified by licence level in order to recognise the significantly different crash risk in each licence level as depicted in Figure 1. Failing to stratify the treatment groups by licence level could potentially result in confounded estimates of crash effects due to the GLS if the distribution of licensed drivers between licence types changed significantly from before to after introduction of the new GLS. As detailed in Table 5, within licence level there were also a number of sub groups defined based on the restrictions applying which were determined by age and time of licensing which defined the 10 treatment groups described. It was of interest to be able to potentially estimate crash effects of the new GLS within each of these 10 treatment groups and within licence level in each of these.

The resulting analysis design is depicted in Table 8. It shows that in the period prior to the new GLS being introduced the licence levels available were Learner (L) - designated L(old) - Provisional (P) and Open (O). The open licence holders identified for analysis were those who had been in the old GLS L or P levels sometime after January 2004. This is distinct from the comparison group open licence holders who can be considered to be more experienced open licence holders generally having obtained their Open licence some years earlier. In order to make a fair comparison with the new GLS licensing levels, the P licence group were split into 2 groups: those in their first year of holding a P licence who should be comparable to the new GLS P1 licence holders, and those in their second and subsequent years holding a of P licence who should be comparable to those in the new GLS P2 level.

In the period post implementation of the new GLS, the available licensing levels were Learner (L), P1, P2 and Open. In addition there were also some licence holders remaining on the old GLS L and P licences with their associated restrictions under the old GLS. Table 8 shows that the evaluation design compares L licence holders under

the new GLS with L licence holders under the old GLS, P1 licence holders under the new GLS with first year P licence holders under the old GLS, P2 licence holders under the new GLS with second and subsequent year P licence holders under the old GLS, and open licence holders who have progressed through the new GLS with open licence holders who have progressed through the old GLS. Each of the treatment groups defined by the new GLS in each licence category was compared to the corresponding single group of corresponding licence category in the pre new GLS period. The only exception to this was the learner group in treatment groups 7 to 10 who all obtained their learner licence under the old GLS and hence were able to be segregated into specific pre new GLS period groups and their crash rates compared from before to after new GLS introduction on the learner level.

Table 8: Primary Evaluation Analysis Design

	Pre New GLS		Post New GLS	
Design Group	**Licence Phase**	**Treatment Group**	**Licence Phase**	**Treatment Group**
Comparison	Open	Comparison	Open	Comparison
L	L (old)	Old GLS Group	L	TG1
			L	TG2
			L	TG3
			L	TG4
			L	TG5
			L	TG6
L7	L (old)	TG7	L (old)	TG7
L8	L (old)	TG8	L (old)	TG8
L9	L (old)	TG9	L (old)	TG9
L10	L (old)	TG10	L (old)	TG10
L			L (old)	Old GLS Group
P1	P First Year	Old GLS Group	P1	TG1
			P1	TG2
			P1	TG3
			P1	TG7
			P1	TG8
P1			P First Year	Old GLS Group
P2	P Second & sub years	Old GLS Group	P2	TG1
			P2	TG2
			P2	TG4
			P2	TG5
			P2	TG7
			P2	TG9
P2			P Second & sub years	Old GLS Group
Open	Open	Old GLS Group	Open	TG1
			Open	TG2
			Open	TG3
			Open	TG4
			Open	TG5
			Open	TG7
			Open	TG8
			Open	TG9
Open			Open	Old GLS Group

Table 8 also shows L, P and Open licence groups from the old GLS carrying over to the period after the introduction of the new GLS. These are noted as belonging to the Old GLS group in the table. Since these groups are unaffected by the new GLS in terms of licence restrictions and conditions, the statistical analyses should exclude those labelled as belonging to the old GLS in the post period of Table 8. It should also exclude the learner phase for Treatment Groups 7-10 in the post new GLS period since the learner licensing conditions for these groups was also unaffected by the new GLS. However, to analyse the total impact of the new GLS on road trauma, it is necessary to consider all novice driver licensing groups in the post period regardless of whether they are progressing through the new GLS or not. The structure of Table 8 allows this assessment to be made as well as assessment of only those licence conditions in groups that have changed under the new GLS.

Analysis of GLS crash effects using the stratified analysis framework presented in Table 8 compared changes in crash rate from before to after new GLS implementation against parallel changes in the comparison group to estimate net crash effects within each design group. The design groups correspond broadly to licence type and are given down the left hand side of Table 8.

3.5 STATISTICAL METHODS

The outcome measure used for the crash analysis is the rate of crashes involving novice drivers with the rate being defined as the crash count divided by licence years of exposure, calculation. Each cell of the analysis design table, Table 8, was populated with the crash count and licence exposure months relating to each treatment group time period and licence type to facilitate the statistical analysis.

A Poisson log-linear regression model was applied to the analysis design to estimate the net crash effects associated with the new GLS adjusted for the effect of non GLS factors represented by the comparison group. The general form of the statistical model was:

$$\ln(y_{ijk}) = \ln(e_{ijk}) + \alpha + \beta_i + \gamma_j + \delta_{ijk} \quad \text{Equation 1}$$

In Equation 1:

i is the index for time period (before new GLS, after new GLS)

j is the index for analysis design group (comparison, L, L1, L7, L8, L9, L10, P1, P2, Open)

k is the index for treatment group within design group (comparison, old GLS group, TG1,..,TG10)

$\alpha + \beta_i + \gamma_j + \delta_{ijk}$ are parameters of the model

y_{ijk} are the cell crash counts

e_{ijk} are the cell exposures (licence months of exposure) - represented in the model as a constant offset term to convert the outcome to a rate rather than a simple crash count.

Some of the parameters in the model are redundant or aliased due to linear dependencies so it was necessary to set these to zero so the model can be estimated. It was decided to set the parameters corresponding to the before time period ($\beta_{before\ GLS}$) and the comparison group ($\gamma_{control}$) design group to zero, along with their corresponding interaction terms as this aided the direct interpretation of the δ_{ijk} as net GLS crash effects. Each interaction parameter $\delta_{afterGLS,j,k}$ represents the relative risk of a crash in analysis design group *j* and treatment group *k*. These can be converted to percentage crash reduction, Δ, in each cell using the formula:

$$\Delta_{afterGLS,j,k} = (1 - \exp(\delta_{afterGLS,j,k})\, x100\%$$

Equation 2

An illustration of how the model structure applies to each cell in the design table is given in Table 9. Separate models were applied to each crash severity considered. These were;

- Fatal crashes
- Fatal and Serious Injury crashes
- All reported crashes

Crash effects were first estimated using all the post new GLS implementation data cells, including those carrying over with the old GLS licensing restrictions (L (old), P First Year (old), P Second and Subsequent Years (old) and Open (old), as well as TG7, 8, 9, 10). This measured the total impact of the new GLS program. A second analysis then assessed only those licence types where restrictions had changed under the new GLS. This measured the pure impact of the new GLS on crash risk.

The form of Equation 1 gives the estimated crash effects associated with the GLS within each licence type and treatment groups. Average crash effects associated with the GLS across groups of analysis strata were measures by constraining the interaction parameters, δ_{ijk}, in the model. A number of average crash effects were estimated as follows:

Average Crash Effect	**Interaction Parameter Constraints**
Whole Program	$\delta_{Aft,j,k} = \delta_{Aft}$ for all *j*, *k*
Within Licence Type	$\delta_{Aft,j,k} = \delta_{Aft,j}$ for all *k*
Within Treatment Group	$\delta_{Aft,j,k} = \delta_{Aft,k}$ for all *j*

Table 9: Statistical Model Parameters Describing the Analysis Data Table

	Pre New GLS		Post New GLS	
Design Group	**Analysis Cell**	**Model form**	**Analysis Cell**	**Model form**
Comparison	Open Comparison	α	Open Comparison	$\alpha + \beta_{Aft}$
L	L (old)	$\alpha + \gamma_L$	L TG1	$\alpha + \beta_{Aft} + \gamma_L + \delta_{Aft,L,TG1}$
			L TG2	$\alpha + \beta_{Aft} + \gamma_L + \delta_{Aft,L,TG2}$
			L TG3	$\alpha + \beta_{Aft} + \gamma_L + \delta_{Aft,L,TG3}$
			L TG4	$\alpha + \beta_{Aft} + \gamma_L + \delta_{Aft,L,TG4}$
			L TG5	$\alpha + \beta_{Aft} + \gamma_L + \delta_{Aft,L,TG5}$
			L TG6	$\alpha + \beta_{Aft} + \gamma_L + \delta_{Aft,L,TG6}$
L7	L (old) TG7	$\alpha + \gamma_{L7}$	L (old) TG7	$\alpha + \beta_{Aft} + \gamma_{L7} + \delta_{Aft,L7,TG7}$
L8	L (old) TG8	$\alpha + \gamma_{L8}$	L (old) TG8	$\alpha + \beta_{Aft} + \gamma_{L8} + \delta_{Aft,L8,TG8}$
L9	L (old) TG9	$\alpha + \gamma_{L9}$	L (old) TG9	$\alpha + \beta_{Aft} + \gamma_{L9} + \delta_{Aft,L9,TG9}$
L10	L (old) TG10	$\alpha + \gamma_{L10}$	L (old) TG10	$\alpha + \beta_{Aft} + \gamma_{L10} + \delta_{Aft,L10,TG10}$
L			L (old)	$\alpha + \beta_{Aft} + \gamma_L + \delta_{Aft,L,L(Old)}$
P1	P First Year	$\alpha + \gamma_{P1}$	P1 TG1	$\alpha + \beta_{Aft} + \gamma_{P1} + \delta_{Aft,P1,TG1}$
			P1 TG2	$\alpha + \beta_{Aft} + \gamma_{P1} + \delta_{Aft,P1,TG2}$
			P1 TG3	$\alpha + \beta_{Aft} + \gamma_{P1} + \delta_{Aft,P1,TG3}$
			P1 TG7	$\alpha + \beta_{Aft} + \gamma_{P1} + \delta_{Aft,P1,TG7}$
			P1 TG8	$\alpha + \beta_{Aft} + \gamma_{P1} + \delta_{Aft,P1,TG8}$
P1			P First Year (old)	$\alpha + \beta_{Aft} + \gamma_{P1} + \delta_{Aft,P1,P(Old)}$
P2	P Second & sub years	$\alpha + \gamma_{P2}$	P2 TG1	$\alpha + \beta_{Aft} + \gamma_{P2} + \delta_{Aft,P2,TG1}$
			P2 TG2	$\alpha + \beta_{Aft} + \gamma_{P2} + \delta_{Aft,P2,TG2}$
			P2 TG4	$\alpha + \beta_{Aft} + \gamma_{P2} + \delta_{Aft,P2,TG4}$
			P2 TG5	$\alpha + \beta_{Aft} + \gamma_{P2} + \delta_{Aft,P2,TG5}$
			P2 TG7	$\alpha + \beta_{Aft} + \gamma_{P2} + \delta_{Aft,P2,TG7}$
			P2 TG9	$\alpha + \beta_{Aft} + \gamma_{P2} + \delta_{Aft,P2,TG9}$
P2			P Second & sub years (old)	$\alpha + \beta_{Aft} + \gamma_{P2} + \delta_{Aft,P2,P2(Old)}$
Open	Open	$\alpha + \gamma_O$	Open TG1	$\alpha + \beta_{Aft} + \gamma_O + \delta_{Aft,O,TG1}$
			Open TG2	$\alpha + \beta_{Aft} + \gamma_O + \delta_{Aft,O,TG2}$
			Open TG3	$\alpha + \beta_{Aft} + \gamma_O + \delta_{Aft,O,TG3}$
			Open TG4	$\alpha + \beta_{Aft} + \gamma_O + \delta_{Aft,O,TG4}$
			Open TG5	$\alpha + \beta_{Aft} + \gamma_O + \delta_{Aft,O,TG5}$
			Open TG7	$\alpha + \beta_{Aft} + \gamma_O + \delta_{Aft,O,TG7}$
			Open TG8	$\alpha + \beta_{Aft} + \gamma_O + \delta_{Aft,O,TG8}$
			Open TG9	$\alpha + \beta_{Aft} + \gamma_O + \delta_{Aft,O,TG9}$
Open			Open (old)	$\alpha + \beta_i + \gamma_O + \delta_{Aft,O,O(Old)}$

4 PRIMARY EVALUATION: RESULTS

In order to compare the overall pattern of crashes involving novice drivers on the new GLS with those of novice drivers under the old GLS (as depicted in Figure 1) the number of casualty crashes by months held each licence phase (L, P1, and P2) were calculated. The results are shown in Figure 3 which is very similar in shape to Figure 1 which was calculated under the old GLS system in Queensland. It shows a relatively constant trend during months held on the Learner phases followed by an immediate large step increase to the start of the P1 phase followed by a sustained fall over the P1 and P2 periods. It should be noted that the crash numbers reported under the later months after P2 licence are likely to be under reported given the relatively small number of P2 licence holders in the data at the time of analysis. Furthermore, fully accurate representation of the data in the chart is somewhat difficult given the variable period over which P1 licences are held under the new GLS. This is in contrast to the old GLS where the P licence period was for a fixed time period with automatic progression to the Open licence.

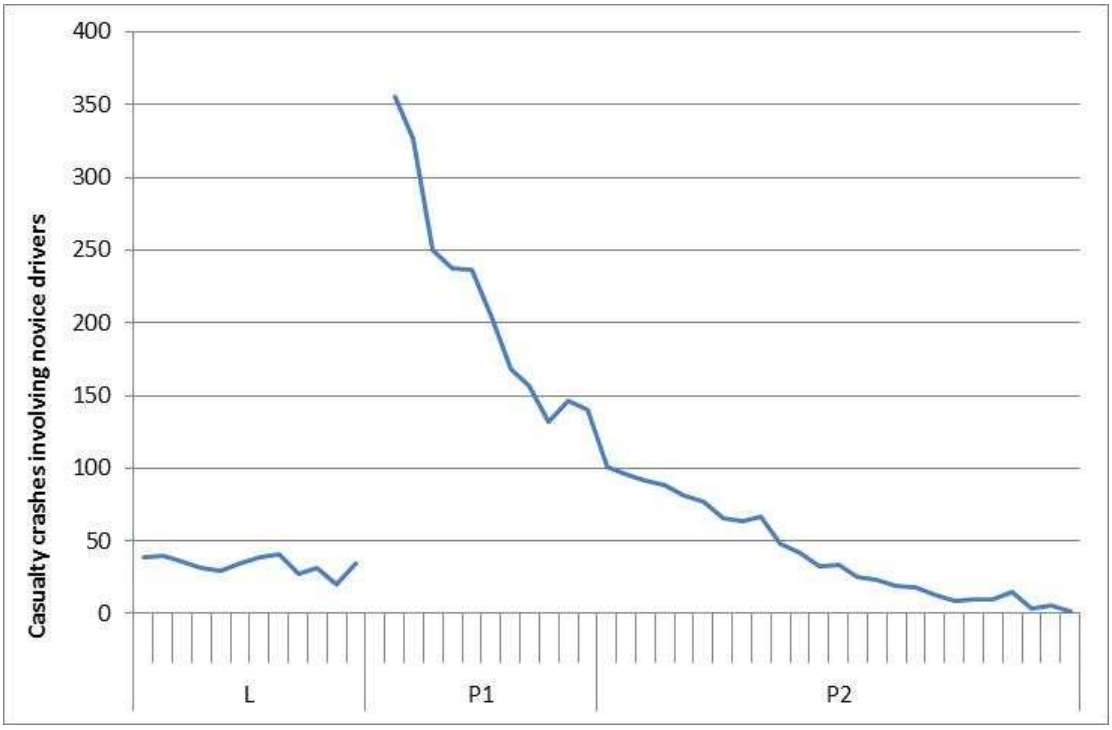


Figure 3: Number of casualty crashes by licence phase and months held

The analysis design table (as depicted in Table 8) was populated with exposure, crash count, and resulting crash rates for each of the three levels of crash severity analysed – all crash severities, fatal and serious injury and fatal. These results are shown in Table 10, Table 11 and Table 12 respectively. In each of the tables, exposure has been expressed in units of person months of exposure. The crash rates have been expressed as crashes per 10,000 person months of exposure, in order to make the numbers a reasonable order of magnitude for presentation.

Table 10: Analysis Data - All Reported Crashes

	Pre New GLS					Post New GLS			
Design Group		**Exposure**	**Crashes**	**Crash rate**			**Exposure**	**Crashes**	**Crash rate**
Comparison	Open Comparison	14284774	15579	10.9060		Open Comparison	11421298	11810	10.3403
						L TG1	1405925	486	3.4568
						L TG2	11514	6	5.2110
L	L (old) Old GLS Group	1394703	707	5.06918		L TG3	8691.5	3	3.4516
						L TG4	21601	15	6.9441
						L TG5	81929.5	39	4.7602
						L TG6	561137	328	5.8453
L7	L (old) TG7	351179	141	4.0150		L (old) TG7	431417	188	4.3577
L8	L (old) TG8	32103.5	20	6.2299		L (old) TG8	22329	11	4.9263
L9	L (old) TG9	326699	203	6.2137		L (old) TG9	223114.5	121	5.4232
L10	L (old) TG10	327173.5	303	9.2611		L (old) TG10	667110	364	5.4564
L						L(old) Old GLS	7260.5	14	19.2824
						P1 TG1	428675	2010	46.8887
						P1 TG2	1179.5	4	33.9127
P1	P First Year Old GLS Group	1217454	5050	41.4800		P1 TG3	776	3	38.6598
						P1 TG7	721397.5	2652	36.7620
						P1 TG8	12710.5	38	29.8965
P1						P 1st Yr Old GLS	351049.5	1270	36.1772
						P2 TG1	56202	134	23.8426
						P2 TG2	31	0	0.0000
P2	P Second & sub years Old GLS Group	649248	1721	26.5076		P2 TG4	1719.5	2	11.6313
						P2 TG5	23273.5	57	24.4914
						P2 TG7	309493.5	716	23.1346
						P2 TG9	107090.5	213	19.8897
P2						P 2+ Yr Old GLS	2079369	4999	24.040947
						Open TG1	0	0	0.0000
						Open TG2	0	0	0.0000
						Open TG3	38	0	0.0000
Open	Open Old GLS Group	244849	426	17.3985		Open TG4	104	1	96.1538
						Open TG5	3987.5	6	15.0470
						Open TG7	12	0	0.0000
						Open TG8	4890.5	10	20.4478
						Open TG9	68765	131	19.0504
Open						Open Old GLS	1575301	2557	16.2318

Table 11: Analysis Data – Fata and Serious Injury Crashes

	Pre New GLS					Post New GLS			
Design Group		**Exposure**	**Crashes**	**Crash rate**			**Exposure**	**Crashes**	**Crash rate**
Comparison	Open Comparison	14284774	5302	3.7116		Open Comparison	15881587	6105	3.8441
L	L (old) Old GLS Group	1394703	162	1.1615		L TG1	2057095	146	0.7097
						L TG2	17413	1	0.5743
						L TG3	13407.5	0	0.0000
						L TG4	33254.5	5	1.5036
						L TG5	121729	8	0.6572
						L TG6	1395336	162	1.1610
L7	L (old) TG7	351179	39	1.1105		L (old) TG7	463248.5	41	0.8851
L8	L (old) TG8	32103.5	3	0.9345		L (old) TG8	25829.5	3	1.1615
L9	L (old) TG9	326699	44	1.3468		L (old) TG9	246020	21	0.8536
L10	L (old) TG10	327173.5	89	2.7203		L (old) TG10	933954	129	1.3812
L						L(old) Old GLS	8265.5	4	4.8394
P1	P First Year Old GLS Group	1217454	967	7.9428		P1 TG1	992538	851	8.5740
						P1 TG2	4461	4	8.9666
						P1 TG3	3141	1	3.1837
						P1 TG7	866520.5	573	6.6127
						P1 TG8	17914.5	9	5.0239
P1						P 1st Yr Old GLS	351857	236	6.7073
P2	P Second & sub years Old GLS Group	649248	312	4.8056		P2 TG1	364031	185	5.0820
						P2 TG2	595.5	0	0.0000
						P2 TG4	6421.5	4	6.2291
						P2 TG5	55969.5	33	5.8961
						P2 TG7	691028	278	4.0230
						P2 TG9	144487.5	61	4.2218
P2						P 2+ Yr Old GLS	2274225	1098	4.8280
Open	Open Old GLS Group	244849	98	4.0025		Open TG1	13.5	0	0.0000
						Open TG2	28.5	0	0.0000
						Open TG3	509	0	0.0000
						Open TG4	1729.5	2	11.5640
						Open TG5	25202.5	12	4.7614
						Open TG7	26451	11	4.1586
						Open TG8	12158	3	2.4675
						Open TG9	168050.5	86	5.1175
Open						Open Old GLS	2983825	1051	3.5223

Table 12: Analysis Data - Fatal Crashes

	Pre New GLS					Post New GLS			
Design Group		**Exposure**	**Crashes**	**Crash rate**			**Exposure**	**Crashes**	**Crash rate**
Comparison	Open Comparison	14284774	231	0.1617		Open Comparison	19518950	313	0.1604
L	L (old) Old GLS Group	1394703	1	0.00717		L TG1	2247509	1	0.0044
						L TG2	19298	0	0.0000
						L TG3	14841	0	0.0000
						L TG4	36979.5	0	0.0000
						L TG5	133189.5	0	0.0000
						L TG6	2639899	13	0.0492
L7	L (old) TG7	351179	1	0.0285		L (old) TG7	469465	2	0.0426
L8	L (old) TG8	32103.5	0	0.0000		L (old) TG8	26783.5	0	0.0000
L9	L (old) TG9	326699	1	0.0306		L (old) TG9	249611	0	0.0000
L10	L (old) TG10	327173.5	10	0.3056		L (old) TG10	1156324	15	0.1297
L						L(old) Old GLS	8558.5	0	0
P1	P First Year Old GLS Group	1217454	42	0.3450		P1 TG1	1565905	39	0.2491
						P1 TG2	9115	0	0.0000
						P1 TG3	6859.5	0	0.0000
						P1 TG7	955488.5	14	0.1465
						P1 TG8	21656	1	0.4618
P1						P 1st Yr Old GLS	352435	11	0.3121
P2	P Second & sub years Old GLS Group	649248	12	0.1848		P2 TG1	896968.5	17	0.1895
						P2 TG2	2086	0	0.0000
						P2 TG4	13571.5	0	0.0000
						P2 TG5	88456.5	3	0.3391
						P2 TG7	879215	14	0.1592
						P2 TG9	164024.5	5	0.3048
P2						P 2+ Yr Old GLS	2328972	44	0.0000
Open	Open Old GLS Group	244849	8	0.3267		Open TG1	30423	0	0.0000
						Open TG2	408.5	0	0.0000
						Open TG3	1847	0	0.0000
						Open TG4	6225.5	0	0.0000
						Open TG5	65380.5	2	0.3059
						Open TG7	230519.5	1	0.0434
						Open TG8	20772.5	1	0.4814
						Open TG9	277912.5	4	0.1439
Open						Open Old GLS	4265867	41	0.0961

A convenient feature of each of Table 10, Table 11 and Table 12 is that the crash rate of the comparison group is very similar from before to after with a maximum variation of 5.6% in the all reported crash group and less than 1% in the fatal crash group. This means that before and after crash rates in the treatment groups can be compared directly to get an indication of the crash effects associated with the GLS. For example, the fatal crash data in Table 12 shows the crash rate in the pre new GLS period to be 0.00717 in comparison to 0.0044 in the post GLS period for Treatment Group 1 (TG1) indicating reduction in learner fatal crash risk of around 38% for new GLS group TG1.

Similar comparisons can be made elsewhere in the tables and gives an indication of the point estimate crash effect results that will be produced by the regression analysis.

Comparisons of the raw crash rate data give some indication of the crash effects associated with introduction of the new GLS. However, such comparisons offer no means of testing the statistical significance of the estimates. Significance testing is critical to provide scientific evidence that the point estimates obtained were likely to be real effects and not simply an artefact of chance variation in the data. The regression analysis statistical modelling provides the means by which to test the statistical significance of the estimate crash effects.

Results of the regression modelling are given in Table 13 including estimated crash reduction associated with the GLS, the statistical significance of the estimate and upper and lower 95% confidence limits. Crash reduction estimates which are statistically significant at the 10% level are highlighted in order to identify these results for which there is some level of statistical confidence. Results which are statistically significant at the 5% level are also shown in bold to emphasise results with the greatest statistical reliability. Analysis results are presented for some specific treatment groups and licence types as well as on average across various treatment and licence type groups as indicated in the results table. Results are presented separately for the 3 different levels or groupings of crash severity.

1. Overall program including old GLS: The first block of analysis results presented in Table 13 gives the estimated crash reductions associated with the Queensland GLS as an entire intervention from July 2007 onwards. It includes assessment of crash rates for all novice driver licence types both before and after introduction of the new GLS including licence phases from the old GLS that have carried over into the new GLS period. This analysis gives the total impact of the new GLS as implemented on novice driver road trauma in Queensland. As can be seen from Table 13, the greatest crash reduction was estimated for fatal crashes (31%) with the estimated crash reductions diminishing as lower severity crashes were included in the analysis. Each of the crash reductions estimated were statistically significant at the 5% level.
2. Overall program only new GLS: The second block of analysis results presented in Table 13 assesses the overall impact of the new GLS, only amongst those licence holders who have been through at least one licence phase under the new GLS. That is, it excludes licence holders that are still on L and P phases subject to the old GLS requirements that have carried on past July 2007 and new open licence holders who have been through only the old GLS L and P phases. This analysis gives a more pure estimate of the overall crash changes associated with the restrictions and requirements of the new Queensland GLS. The same pattern in crash reduction estimates by crash severity as observed for the first analysis are again seen here with decreasing crash reductions by crash severity. In this case the estimated reduction in all reported crashes is no longer significant and the fatal crash reduction estimate is only marginally statistically significant ($0.05 < p < 0.1$). The lower level of statistical significance for these estimates reflects both the smaller crash reductions estimated for each severity along with the smaller quantities of crash data on which the analysis are based compared to the first block of results.
3. Only new GLS by licence type: The third block of analysis results estimates crash reductions associated with the new GLS by licence phase and crash severity. There is some inconsistency in estimated effects between crash

severity levels in terms of relativity between the licence phases. This is partly a reflection of the different quantities of crash data available for each licence phase and crash severity manifesting in varying levels of statistical significance. Highly statistically significant crash reductions were estimated for fatal crashes amongst P1 licence holders, fatal and serious injury crashes involving learner drivers, and all crash reported crashes involving learner and P2 drivers. Marginally statistically significant crash reductions were also estimated for open licence fatal crashes, and fatal and serious injury P1 drivers.

Attempts to estimate crash reductions associated with the new GLS within the 10 specific treatment groups and by licence phases within those treatment groups gave results with no statistical reliability and hence are not reported here. Again, this reflects the limited quantity of crash data, in many instances stemming from limited licensing exposure, in many of the analysis design cells in Table 10, Table 11 and Table 12. The lack of statistical significance in these analyses meant that no robust conclusions could be drawn. Being able to contrast the crash reductions estimated in each of the 10 specific treatment groups would have allowed the effects of specific GLS initiatives to be estimated (such as the minimum supervised driving hours for learners).

Two further analyses were undertaken based on treatment groups or specific contrasts that were likely to be of importance to understanding the mechanisms of GLS effectiveness.

4. TG1-6 vs. TG 7-10: The first estimated crash effects associated with those treatment groups where licence holders had completed the Learner phase under the old GLS (TG7-10) in comparison to those completing the learner phase under the new GLS (TG1-6). Contrasting average crash effects across these two grouping gave the potential to understand the impact the new learner phase restrictions under the new GLS, covering hours of experience and supervision, were likely to have on crash rates. Results of this analysis are presented in the fourth block of Table 13. Overall, the results suggest greater crash reductions associated with those who have completed the learner phase under the old GLS. Estimates of crash effects for fatal and serious injury crashes combined, as well as for all reported crashes, were statistically significantly different between the two groups as show by the non-overlapping confidence limits on the estimates. A statistically significant increase of almost 10% in all reported crashes was estimated for TG1-6.

5. TG1 licence type: The final analysis undertaken was to estimate the crash effects associate with analysis Treatment Group 1. This group is of primary interest as it covers those who complete progress through the new GLS licensing phases with no age-based exemptions, and is likely to be the group most representative of the long term crash effect of the new GLS in Queensland. Given the data available it was only possible to estimate associated crash effect for this group in the L, P1 and P2 phase since there were no reported open phase crashes from their very limited licence exposure accumulated at the time of study. Table 13 shows statistically significant reductions in all reported crashes and fatal and serious injury crashes combined in the learner phase for this treatment group of 28% and 41% respectively. Estimated reductions in learner and P1 fatal crashes were of a similar magnitude although neither was statistically significant. Point estimates of crash

effects associated with all other phases were around 5% or less with none being statistically significant.

Table 13: Estimated Net Crash Effects Associated with the Queensland GLS for crashes involving novice drivers

Analysis Level	Crash Severity	Licence Level or Group	% Crash Reduction*	Stat. Sig.**	95% Confidence Interval	
					Upper	Lower
Overall Program Including Old GLS* **	Fatal	All	**30.67%**	**0.0253**	49.70%	4.44%
	Fatal + SI	All	**13.23%**	**0.0000**	18.94%	7.12%
	All Crashes	All	**3.74%**	**0.0397**	7.17%	0.18%
Overall Program Only New GLS* **	Fatal	All	26.10%	0.0925	48.05%	-5.12%
	Fatal + SI	All	**9.13%**	**0.0113**	15.61%	2.15%
	All Crashes	All	1.27%	0.5347	5.19%	-2.80%
Only New GLS by Licence Type* **	Fatal	Learner	-286.72%	0.1929	49.51%	-2861.84%
		P1	**38.32%**	**0.0305**	60.18%	4.45%
		P2	-4.09%	0.9066	46.68%	-103.20%
		Open	59.03%	0.0787	84.85%	-10.77%
	Fatal + SI	Learner	**26.43%**	**0.0018**	39.30%	10.83%
		P1	7.24%	0.0994	15.18%	-1.43%
		P2	10.72%	0.1207	22.63%	-3.03%
		Open	-17.48%	0.2467	10.54%	-54.27%
	All Crashes	Learner	**12.73%**	**0.0088**	21.18%	3.36%
		P1	-2.76%	0.2503	1.90%	-7.63%
		P2	**10.32%**	**0.0068**	17.13%	2.96%
		Open	-15.32%	0.1383	4.49%	-39.25%
TG1-6 vs. TG7-10 (only new GLS)* **	Fatal	TG1-6	13.92%	0.4409	41.21%	-26.03%
		TG7-10	**41.48%**	**0.0165**	62.22%	9.33%
	Fatal + SI	TG1-6	-0.12%	0.9778	7.87%	-8.80%
		TG7-10	**18.78%**	**0.0000**	25.63%	11.30%
	All Crashes	TG1-6	**-9.96%**	**0.0002**	-4.59%	-15.61%
		TG7-10	**8.26%**	**0.0002**	12.38%	3.96%
TG1 by Licence Type* **	Fatal	Learner	37.42%	0.7408	96.11%	-905.71%
		P1	27.20%	0.1836	54.40%	-16.23%
		P2	-3.41%	0.9310	51.56%	-120.73%
	Fatal + SI	Learner	**41.00%**	**0.0000**	52.97%	25.99%
		P1	-4.23%	0.4133	5.62%	-15.10%
		P2	-2.11%	0.8255	15.18%	-22.93%
	All Crashes	Learner	**28.08%**	**0.0000**	36.08%	19.07%
		P1	**-19.22%**	**0.0000**	-12.62%	-26.21%
		P2	5.13%	0.5604	20.55%	-13.28%

** NB: Negative crash reduction estimates indicate an estimated crash increase.*

*** Significance values of 0.0000 indicate a statistical significance of less than 0.0001*

**** For each block of analyses see results as discussed page 45, and see description of each block of analyses on page 26*

Using the base crash rate data from Table 11, and the estimated net crash effects in Table 13, Figure 4 presents actual fatal and serious injury crash rates prior to the new GLS and fatal and serious injury crash rates post new GLS - adjusted for changes in the comparison group (open licence) crash rates. Figure 4 is analogous to Figure 1 but is more accurate in that it is corrected for relative exposure. Estimates for fatal and serious injury crash rates are presented as this is the crash severity grouping where the new GLS seems to be associated with the largest crash effects as well as where the estimated crash effects in Table 13 are most reliable by licence type. The pattern in relative crash risks between licence types shown in Figure 4 is similar to those in Figure 1 and Figure 3 although the magnitude of the differences between licence types

is different, demonstrating the value of exposure in correcting the crash effect estimates.

Using the observed post new GLS crash fatal and serious injury crash counts in Table 11, and the estimated net crash effects associated with the new GLS in Table 13, it was also possible to estimate the absolute numbers of crashes saved by the GLS by licence type over the period from July 2007 to December 2010. The estimated total savings in fatal and serious injury crashes combined over this time period associated with the Queensland GLS was in the order of 430 of which around 260 were for learner licence holders, around 110 for P1 licence holders and around 70 for P2 licence holders.

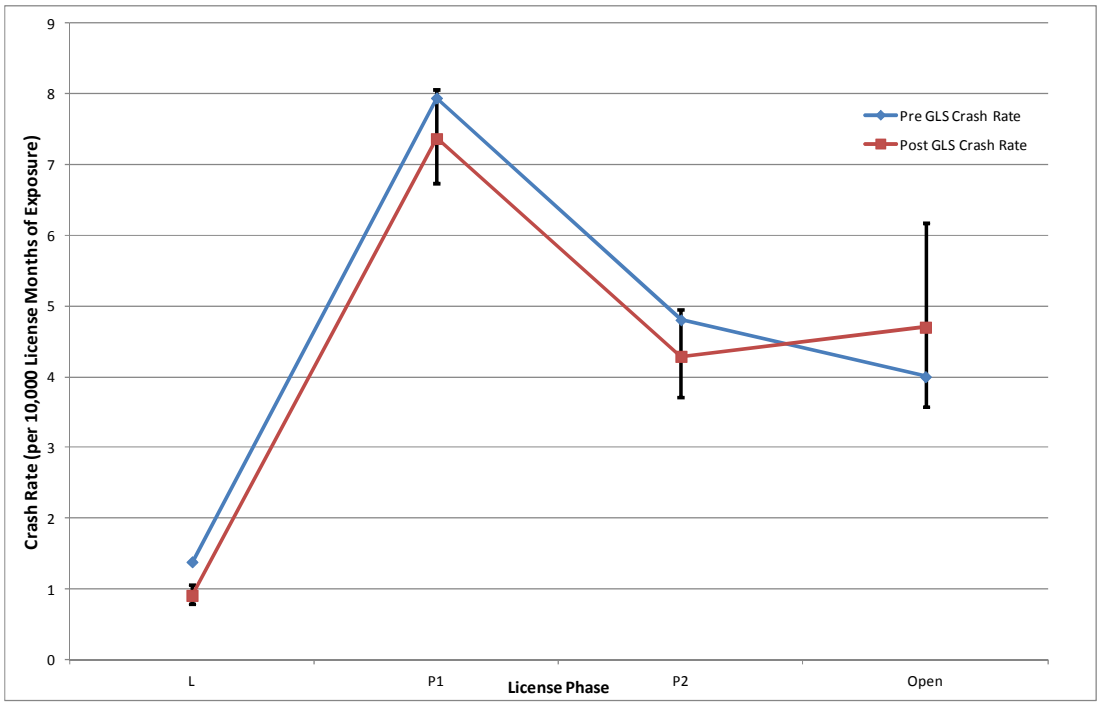


Figure 4: Fatal and Serious Injury Crash Rates Pre and Post new GLS Introduction by Licence Type (Post GLS Crash Rates Adjusted for Changes in Comparison Group Crashes)

5 PRIMARY EVALUATION: DISCUSSION

The aim of this study was to evaluate the effectiveness of the changes made to the GLS by the Queensland Government in terms of their effect on rates of crashes reported to police. The analysis aimed to estimate the crash effects associated with the program both overall, within specific crash severity levels and within specific licensing phases. It was intended to contrast the crash effects amongst those that have been subject to differing requirements, restrictions and licence phase progression of the GLS resulting from different paths of progression through the new GLS due to its the phased introduction for licence holders of different ages and times of licensing. It was hoped that contrasting crash effects across these different pathway groups would enable contrast to be made which would shed light on the effectiveness of specific elements of the new GLS (as listed in Table 1).

To achieve these goals, a necessarily complex but comprehensive evaluation structure was developed. A key to defining the evaluation structure was to understand the different pathways by which licence holders could progress through the new GLS systems in Queensland. These have been documented in Table 4 and define 10 different groups based primarily on whether drivers obtained their L licence under the new or old GLS system and how old they were at various licence transition points. Two of the groups were of those who still only had a learner licence. Members of these groups will ultimately move to one of the other groups at a later time when they have progressed to the next phase of licence.

Examination of these groups revealed the potential to make a number of specific contrasts between groups that ultimately will help understand the effectiveness of specific aspects of the GLS in reducing crash rates. Aspects that have the potential for specific evaluation include the new learner log book, the effectiveness of different paths of progression (e.g. not having to hold a P1 or P2 licence and the associated restrictions), and different lengths of P2 holding period. One limitation that will always be present when making these contrasts is potential confounding. Many of the contrasts of primary interest are between groups with different age requirements. Hence any estimate of relative effectiveness related to the different requirements will necessarily be at least partially confounded with driver age at time of licensing. Despite this, these contrasts offer at least some potential to measure the relative effectiveness of different aspects of the new GLS through internal comparisons beyond what has been possible in most previous studies (see Table 3).

The design of the evaluation framework used in this study is quasi-experimental. The use of a comparison group in this design is the most powerful available means of controlling for the confounding effects of other factors affecting crash rates in Queensland, both measurable and un-measurable, beyond the GLS being evaluated. The population of drivers affected by the new GLS in Queensland are predominantly young with all young drivers from July 2007 being potentially influenced by the program. This meant that a comparison group could not be matched by age so the next nearest age bracket to the novice driver group, 25-35 year olds, were chosen for the comparison group. Only open licence holders were used in the comparison group as the new GLS has not influenced conditions on open licences. It is acknowledged that choosing an older age bracket of drivers to use as the comparison will potentially introduce age bias effects particularly if the other factors being represented by the comparison group affect older drivers differently to younger drivers. It is considered the magnitude of this bias, of present, is likely to be small. An illustration of the likely

small magnitude of this bias can be seen by examining the relative unemployment rates within the treatment and comparison groups over time which is available from the Australian Bureau of Statistics. Unemployment rate was considered as previous studies have found a strong association between road trauma levels and unemployment rate (for example Scuffham and Langley, 2002). Due to this association, differential trends in unemployment rates between cohorts may lead to differential trends in road trauma over time. Figure 5 shows the ratio of monthly unemployment rate in the 25-34 year old comparison group to that in the 15-24 year old treatment group. A linear trend line in the comparison is also shown. It shows that whilst unemployment in the comparison group is consistently lower than that in the treatment group, the relativity between the two groups is consistent. This means that the comparison group will adequately reflect changes in unemployment rate, and hence its influence on road trauma, in the treatment group from before to after introduction of the GLS.

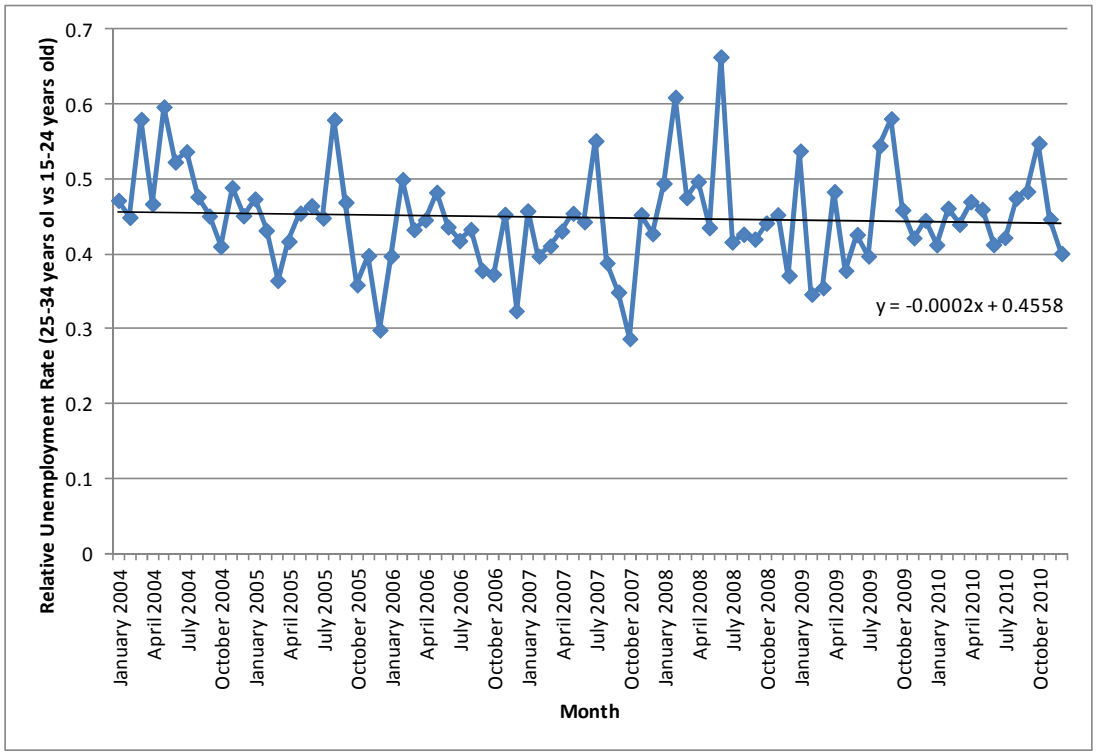


Figure 5: Relative unemployment rates in Queensland by Month: 25-34 year olds relative to 15-24 year olds

A further key strength of the analysis design developed is the ability to specifically compare crash outcomes of similar licensing types from before to after implementation of the new GLS. Previous studies have clearly established the variation in crash rates between different licensing types (Figure 1) which has been confirmed here (Figure 3). This makes measuring changes in crash rates in comparable licence types imperative for a strong evaluation design. The old GLS had only a single P licence phase between L and Open compared to the new GLS which has both P1 and P2 phases for most drivers. To make the comparison as specific as possible in the evaluation design, the old P phase was segregated into first year Ps, which should be comparable to the P1 licence phase, and second and subsequent year Ps, which should be comparable to the P2 phase. One difficulty in making this assignment is that, compared to the old P phase

which was fixed at 3 years, the P1 phase is not fixed at one year, requiring the hazard perception test to be passed before progression to P2. However, Table 14 shows that the median length of P1 licence duration was 12 months meaning the comparison with first year P licence holders from the old GLS should be valid.

A final strength of the analysis design is the inclusion of an exposure measure from which to calculate crash rates rather than simply crash counts as the outcome measure. With a lack of detailed information on relative travel exposure of various licence holders at the micro level not just in Queensland but internationally, the only viable and reliable measure of exposure that can be calculated is the total time exposure of various licence holders. As shown in this study, this can be readily calculated from information available in the Queensland licensing system from which high quality data was able to be provided for evaluation. It is possible that there are still confounding effects due to differential travel rates per licence months of exposure between the treatment group pre and post new GLS in the analysis. However, it is likely that changes in travel exposure are linked more to age and time from licensing which should be relatively unaffected by the new GLS. The only exception to this is for the learner group which mandates that all learners under the age of 25 must obtain a minimum of 100 hours of supervised driving experience and hold their learner licence for a minimum of 12-months (as opposed to the old GLS which did not include a mandate on number of hours of supervised driving experience and the minimum holding period was 6-months). Table 14 shows that the median length of learner licence holding under the new GLS is almost 50% longer than under the old GLS suggesting the new requirements affect length of licensing more than average monthly travel minimising the potential impact of this confounder on the crash effect estimates.

Evaluation of the crash effects of the new GLS in Queensland at the program level suggest the new GLS has been effective in its objectives of reducing crash risk amongst novice drivers. The comparison of total average crash rates amongst all novice drivers regardless of their licensing path, from before to after introduction of the new GLS against the comparison group, estimated significant crash reductions associated with new GLS implementation. In addition, the estimates suggested effects were greater for high severity crashes, which is in line with the intentions of the GLS. Estimates of global program effectiveness were similar, albeit with slightly reduced levels of statistical confidence, when those licence holders only subject to old GLS licensing conditions in the post new GLS implementation period were excluded from the analysis. These estimates are more indicative of the pure crash effects associated with the new GLS system, which might be sustained longer term as licence holders subject to the old GLS restrictions slowly progress to open licences.

Results of the evaluation become less clear when interpreting the more specific analysis results by licence phase and treatment group. Relative estimated crash effects across the different licence types were inconsistent across different levels of crash severity which is hard to reconcile. It is most likely an artefact of limited data quantities for certain licence types and crash severity levels, evidenced by the lack of statistical significance of many of the analysis results by licence type. This is a direct reflection of the relatively short after implementation crash data period on which the evaluation was based, a point that will be re-visited later on.

The one analysis that did provide some results of note was that comparing crash effects on average across groups that had completed the learner phase under the old GLS but went onto the new GLS P1 or P2 phase to those completing the learner phase under the

new GLS. Contrary to expectation, this analysis showed significantly higher crash reductions associated with groups that had completed their learner phase under the old GLS. Taking this result at face value would suggest that the new learner requirements are not producing the intended results. However, examining this result in detail shows it is in fact likely to be reasons other than the learner requirements contributing to this result. Table 14 shows that those in treatment groups 7-10 generally held their learner licence for longer than those in treatment groups 1-6 and are consequently older and possibly more experienced when transitioning to a P licence. This suggests they are not typical of the average novice driver. Furthermore drivers in treatment groups 7-10 have also spent more time on the lower risk P2 and Open licence phase meaning the overall comparison is not strictly fare. Unfortunately, attempts to compare crash risk by licence type in treatment groups 1-6 to groups 7-10 produced estimates that lacked statistical reliability. Again this is a reflection on the limited quantities of data available for analysis after the implementation of the new GLS.

As noted, Treatment Group 1 is perhaps the most representative of the path through the GLS that will be taken by most novice drivers. Table 10 shows that total exposure in this group in the learner phase is highest of all those completing the new GLS learner phase confirming the high relevance of this group in terms of representing the likely long term crash effects of the GLS. This is further emphasised through noting that exposure in many of the other groups is currently low and will be expected to remain low given the age profile of newly licensed drivers or will dwindle to zero as the full transition to the new GLS becomes complete.

Crash effects estimated for Treatment Group 1 in Table 13 produced mixed results. They showed significant reductions in crash risk associated with the new GLS learner phase for all reported crashes and fatal and serious injury crashes combined with a suggestion this result will also follow through to fatal crashes alone based on the point estimate of crash effect for fatal crashes. Other results were inconclusive, lacking statistical significance due to insufficient data, partly an artefact of the high proportion of learner drivers in this study group with learner drivers generally having a low crash rate. However, interpretation of the confidence limits on the estimates for the P1 and P2 phases suggests maximum crash reductions associated with these phases will be in the order of 15% or less for fatal and serious injury crashes combined, a key crash group given it represents the bulk of economic cost to society. The significant increase during the P1 phase estimated for all reported crashes is also of some concern all though would not represent a major problem if the bulk of the increase was in low severity crashes. Monitoring of this group in the future will be of key importance to reflect the potential of the GLS program to reduce novice driver crashes.

Results of analysis of the new GLS for specific licence phases and key analysis groups have not provided robust scientific evidence as to the likely long term effectiveness of the new GLS in Queensland. Whilst the evaluation has estimated crash reduction benefits at the broad program level to date, there still remains a question as to whether these benefits will be sustained in the longer term as the majority of newly licensed drivers' transition wholly through the new system.

A primary reason for that lack of evidence on the likely long term effects of the GLS from this evaluation, and the inability of the evaluation to identify the relative effectiveness of different aspects of the GLS is the lack of sufficient data post implementation of the new GLS available for analysis. This is largely a product of the extreme reporting delays which are currently being faced in the release of official crash

data records in Queensland. Despite data for this evaluation being provided in early-2012, fatal crash data was only available up to November 2011, serious injury crash data to December 2010 and minor and non-injury crash data to the end of 2009. The significant data lag in combination with the relatively large number of licence progression permutations possible under the Queensland GLS meant that crash data was very limited in many of the key analysis design cells. A direct consequence of this was to severely limit the scope of the analyses that could be successfully undertaken and the level of understanding about the mechanisms of effectiveness of the new Queensland GLS.

Lack of sufficient post GLS implementation data for this study meant that the statistical analyses undertaken were often underpowered (i.e. there was insufficient crash data to lead to a statistically significant, that is, reliable, crash change being identified). There was an inability to consistently detect crash effects associated with the GLS at anything but the broadest program level. Estimating statistical power and hence the amount of additional data required to produce statistically robust estimates is difficult for the analysis methodology used in this study. In a multivariate regression framework the statistical power related to each factor in the model is partly related to the combined effects of the other factors hence it is difficult to estimate the data requirements to increase the power in one factor in isolation. The best way in which to consider the additional data requirements to obtain statistical significance from the analysis results is to examine the point estimates of non-significant results from this study in relation to the levels of statistical significance recorded and the corresponding confidence limits. At the licence type level of analysis, statistically reliable results were only obtained for effect sizes above around 27% for fatal and serious injury crashes. Crash reduction estimates of 7-10% were estimated for fatal and serious injury crashes in the P1 and P2 phases that had marginal or no statistical significance. Within the key Treatment Group 1, fatal crash reduction estimates of 27% and above were not statistically significant whilst only reductions in fatal and serious injury crashes of 40% were significant. This implies that within individual treatment groups, up to twice the data that was currently analysed would be required to be able to detect crash reductions of 20% or less with statistical reliability which equates to an additional 2-3 years of data. It is critical that analysis results in the individual treatment groups have a high statistical reliability in order to be able to identify the specific elements of the GLS which have led to crash reductions.

Based on the noted problems faced by this evaluation, a clear recommendation from the research is to undertake further evaluation of the Queensland GLS when additional crash data is available for analysis. Based on the results obtained, it is recommended that a re-analysis be conducted when 2 to 3 years of additional crash data are available. The evaluation framework that has been set up in this study offers great potential to deliver a strong understanding of the crash effects associated with the Queensland GLS program. Knowledge generated from effective application of the framework to an adequate period of after implementation data could make a significant contribution to novice driver licensing policy in Queensland and internationally.

Table 14: Licensing age and holding duration properties of different licensing groups

	Pre New GLS						Post New GLS				
Design Group	Licence Phase / Treatment Group	Median (months)	75th Percentile (months)	Age Range (years)	Age mean		Licence Phase/ Treatment Group	Median (months)	75th Percentile (months)	Age Range (years)	Age mean
Comparison	Open Comparison						Open Comparison				
L	L (old) Old GLS Group	9	19	8 - 94	17.8		L TG1	14	19	15 - 21	16.2
							L TG2	21	29	18 - 22	21.0
							L TG3	21	29	19 - 23	22.1
							L TG4	22	30	20 - 24	23.3
							L TG5	14	20	25 - 81	34.5
							L TG6	15	27	15 - 80	18.9
L7	L (old) TG7	10	22	16 - 22	16.6						
L8	L (old) TG8	61	83	16 - 24	19.1						
L9	L (old) TG9	65	107	16 - 79	24.5						
L10	L (old) TG10	65	76	16 - 93	21.3						
L											
P1	P plates old GLS	36	36	9 - 94	19.6		P1 TG1	12	13	16 - 22	17.5
							P1 TG2	12	13	23 - 23	23.0
							P1 TG3	12	13	24 - 24	24.0
							P1 TG7	14	23	17 - 22	18.1
							P1 TG8	12	18	24 - 24	24.0
P1											
P2							P2 TG1	2	13	17 - 25	18.4
							P2 TG2	0	4	24 - 26	24.1
							P2 TG4	12	12	25 - 28	25.4
							P2 TG5	12	12	25 - 82	35.8
							P2 TG7	24	24	17 - 26	19.3
							P2 TG9	12	12	25 - 82	30.4
P2											
Open	Open Old GLS Group	126	164	25-35	29.2		Open TG1	0	0	19 - 25	20.0
							Open TG2	0	0	25 - 26	25.1
							Open TG3	0	3	25 - 27	25.1
							Open TG4	0	7	26 - 28	26.3
							Open TG5	5	15	18 - 83	36.5
							Open TG7	3	10	19 - 26	20.8
							Open TG8	14	30	25 - 28	25.3
							Open TG9	23	33	18 - 83	31.4
Open											

6 SECONDARY EVALUATION: OVERVIEW

The aims of the Secondary Evaluation of the new Queensland GLS were to assess the effectiveness of individual initiatives of the new GLS introduced on 1 July 2007 using a range of data sources in addition to the police reported crash data used for the Primary Evaluation. The major and supporting initiatives that represent the new GLS are summarised in Table 1 and re-iterated in Table 15 against the other available data sources. All initiatives directly relate to the GLS, other initiatives that were introduced around the GLS implementation date (for example, random roadside drug testing) are not the focus of the evaluation but are taken into consideration in the statistical analysis to control for confounding effects through the inclusion of a comparison group of drivers where appropriate.

The methodological difficulties associated with evaluating marginal effects associated with each GLS initiative individually has been discussed in the literature review. In terms of their relationship with the key outcome of crashes the effects of many of the initiatives are fully or partially confounded or confounded with a secondary variable such as driver age. For this evaluation there were also limited quantities of after implementation crash data for many key licensing groups with contrasting GLS conditions. This meant that evaluating the effects of individual GLS initiatives through contrasting effects between licensing groups was not possible. Therefore, the Secondary Evaluation involved the use of a range of data sources to estimate the likely effectiveness of individual initiatives in contributing to reductions in road trauma among young novice drivers. The data sources were derived from:

1. Infringements - database of Police infringement and demerit points for infringements and offences
2. UCSR – MUARC database of Used Car Safety Ratings
3. Self-report - self-reported survey data from a sample of P1 drivers
4. Hazard Perception Test (HPT) results - Database of P1 drivers' results to the HPT

A key feature of each of these data sets is that they could be related directly to different licensing groups and hence the relative effects associated with novice drivers could be assessed. Many of these data sources represent intermediate measures of effectiveness rather than a direct effect on crashes. However, in the absence of sufficient crash data, intermediate measures represent the best alternative outcome. The 13 initiatives were analysed using the above combination of data sources as follows:

Table 15: GLS initiatives and evaluation data sources

	Infringements	UCSR + Crash Data	Self-report	HPT
Reducing the minimum age to obtain a Learner licence			✓	
Increasing the minimum Learner period			✓	
Logbook for gaining driving experience	✓		✓	
Restricting mobile phone use	✓		✓	
Restricting loudspeaker devices among passengers	✓		✓	
Requiring that motorbike Learners hold a car licence*				
Two phase intermediate licence system			✓	
Compulsory L-plates and P-plates	✓		✓	
Peer-passenger restrictions	✓		✓	
High-powered vehicle restriction	✓	✓	✓	
Late-night driving restriction for disqualified or suspended drivers	✓		✓	
Media package and educational tools			✓	
Hazard Perception Test for P1 licence holders before applying for P2 licence				✓

* This initiative has been evaluated using crash data alone

7 SECONDARY EVALUATION: INFRINGEMENT DATA

7.1 OVERVIEW

7.1.1 Aims and Methodology

Infringement data was used to carry out two distinct analyses. The first analysis calculated the number of infringements issued to drivers progressing through the new GLS for offences specific to the new GLS. For example, infringements such as breaching the peer passenger restriction are included whereas speeding infringements are excluded as they are not specific to the new GLS. This analysis aimed to isolate each of the new GLS-specific infringements and establish how many of these infringements have been issued since 1 July 2007. The overall aim was to understand the extent to which each of the new GLS-specific regulations are being enforced. Enforcement data such as the number of police operational hours spent on GLS specific activities was unavailable so it was not possible to analyse or control for levels of police enforcement.

The second analysis used infringement data for offences that are not specific to the new GLS and, utilising the Primary Evaluation analysis methodology, compared infringement rates for drivers before and after implementation of the new GLS relative to a comparison group of drivers on their Open licence.

7.1.2 Data

De-identified infringement data were obtained from the TMR registration and licensing database (TRAILS) and merged to the licensing data for each data record of the treatment and comparison groups as outlined in the Primary Evaluation chapter. There were a total of 3,540,664 infringements for car drivers spanning the period 1 July 2002 to 30 October 2011.

7.1.3 Data Preparation: Infringements Specific to the New GLS

To calculate the number of infringements issued for components specific to the new GLS the GLS components that had an associated infringement code were identified in the infringement code data dictionary and then drivers issued with these infringement codes extracted from the database of infringements. The following components were introduced in the new GLS and included a specific infringement code(s) in the infringement data dictionary:

- Logbook for gaining driving experience;
- Restricting mobile phone use for drivers;
- Restricting loudspeaker devices among passengers;
- Compulsory L-plates and P-plates;
- Peer-passenger restrictions;
- High-powered vehicle restriction; and,
- Late-night driving restriction for disqualified or suspended drivers.

7.1.4 Data Preparation: infringements before and after New GLS

The analysis of infringement rates utilised the same analysis methodology as the Primary Evaluation whereby infringement rates were calculated for treatment groups relative to a comparison group based on per months licence exposure. For specific

details on the analysis methodology see the Primary Evaluation chapter. The following levels of analysis were carried out:

1. **Overall assessment of the GLS**: Estimates the overall changes in infringement rates associated with the new GLS. This level of analysis assesses the overall change in infringements associated with the new GLS for:

1.1 Overall program including old GLS: overall program effects of the new GLS (L, P1, P2, Open) including some drivers that were licensed on their Ls and Ps on the old GLS (L (old), P, Open (old))

1.2 Overall program only new GLS: Overall program effects of the new GLS including those licensed fully or partly under the new GLS (L, L (old), P1, P2, Open) but excluding those licensed under the old GLS that are still on the L or P phase after the new GLS implementation

2. **Assessment of new GLS by licence type:** Estimates changes in infringement rates associated with the new GLS by licence level (L, P1, P2 and Open)
3. **Assessment of the new GLS by pre-defined treatment groups (i.e. TG 1-6 vs. TG7-10):** Estimates changes in infringement rates associated with the new GLS by the various pathways by which drivers can progress through the GLS (as defined in Section 3.2). All drivers licensed fully under the new GLS (Treatment Groups 1-6) are compared to those licensed under both new and old GLS (Treatment Groups 7-10)
4. **Assessment of the new GLS by Specific Treatment Group:** Estimates changes in infringement rates associated with the new GLS for drivers in each specific Treatment Group (as defined in Section 3.2). A specific focus will be Treatment Group 1 who progress through all licence phases of the new GLS. Treatment Group 1 comprises the majority of drivers progressing through the GLS because they tend to commence each licence phase at the minimum entry age - for example, they obtain their Learner licence within a few years of turning 16 and progress to P1 around the age of 17 etc.

7.2 RESULTS

Tables of all the infringement data analysed by GLS group and licence phase can be found in Appendix B.

7.2.1 Infringements Specific to New GLS

The number of infringements specific to the new GLS that have been issued between 1 July 2007 and 30 October 2011, as a proportion of the total number of infringements for drivers, is shown below.

Table 16: GLS specific infringements issued: July 2007 and 30 October 2011

Infringement		
All other driving infringements not specific to new GLS	3510821	99.16%
Logbook	0	0.00%
Mobile phone	97	0.00%
Mobile phone supervisors & passengers	4	0.00%
Peer passenger	2720	0.08%
HPV	272	0.01%
Display plates	23990	0.68%
Late night driving	2760	0.08%
Total	**3540664**	**100.00%**

7.2.2 Infringements not specific to the new GLS before and after new GLS

Mirroring the primary evaluation analysis of crashes, the following tables present the results of analysing the net change relative rates of non-GLS specific infringements amongst novice drivers from before to after introduction of the new GLS. The adjusted relative rates presented in the tables are the ratio of infringement rates amongst novice drivers after to those before, corrected by the same ratio in the comparison group of 25-35 year old fully licensed drivers. Adjustment of the novice driver ratio by the comparison group ratio reflect general changes in community as a whole over time in terms of the likelihood of infringement as well as the level of enforcement effort and efficiency by police. The base data on which the analysis has been conducted is given in Appendix B.

Results in each table include the adjusted relative rate of infringement, the statistical significance of this estimate (indicating the probability of obtaining the adjusted relative rate given no real change from before to after new GLS) and the 95% confidence limit on the estimated adjusted relative rate. An adjusted relative rate of 1 indicated no change in infringement rates of novice drivers from before to after introduction of the new GLS relative to the control group. Statistically significant changes in the adjusted relative rate are indicated by an estimate that is different from 1 with a statistical significance value less than 5% and a 95% confidence limit that does not overlap 1. For example in Table 17, the adjusted relative rate for all offences is 0.943 which indicates a 5.7% reduction in the rate of novice driver offences ((1-0.943)x100%) which is statistically significant ($p=0.000<0.05$). In contrast, the adjusted relative rate for hooning offences is 1.366 indicating a 36.6% increase although this is not statistically significant ($p=0.190>0.05$).

Table 17 presents the results of analysing the net change in novice driver infringements after introduction of the new GLS both for all novice drivers regardless of their path through the GLS (1.1.above) as well as for only for those who have had some path through the GLS (1.2 above). As previously, the first analysis gives a measure of the overall effect of the new GLS on novice driver infringements in Queensland, including novice drivers who have not been influenced by the new GLS. In contrast the second analysis gives a measure of the effect on infringements of the new GLS alone and is likely to be reflective of the longer term effects of the new GLS when all novice drivers in Queensland have been licensed under it.

Table 17: Adjusted relative infringement rates after GLS introduction: Overall program

Analysis Level	Offence Type	Licence Level or Group	Adjusted Relative Rate of Infringement Post vs. Pre GLS	Stat. Sig.**	95% Confidence Interval	
					Lower	Upper
Overall Program Including Old GLS	All Infringements	All	.943	0.000	.935	.950
	Unlicensed/Disqualified	All	.969	0.126	.931	1.009
	Unaccompanied Learner	All	.481	0.000	.471	.490
	Speeding	All	.877	0.000	.868	.888
	Seatbelt	All	.700	0.000	.673	.728
	Other	All	.862	0.000	.846	.879
	Mobile phone	All	.914	0.002	.864	.966
	Hooning	All	1.366	0.190	.857	2.177
	Drink Driving	All	5.035	0.000	4.862	5.214
	Disobey Road Signage	All	1.510	0.000	1.447	1.575
Overall Program Only New GLS	All Infringements	All	.798	0.000	.792	.805
	Unlicensed/Disqualified	All	.875	0.000	.840	.912
	Unaccompanied Learner	All	.481	0.000	.471	.490
	Speeding	All	.830	0.000	.820	.840
	Seatbelt	All	.588	0.000	.563	.613
	Other	All	.834	0.000	.818	.850
	Mobile phone	All	.937	0.025	.885	.992
	Hooning	All	1.254	0.349	.781	2.014
	Drink Driving	All	1.954	0.000	1.883	2.027
	Disobey Road Signage	All	1.641	0.000	1.571	1.714

** p=0.000 indicates a significance probability less than 0.001

Table 18 gives estimates of net changes in infringement rates for novice drivers fully or partially affected by the new GLS after the new GLS introduction by licence class for both all infringements combined as well as for specific infringement types. Table 19 gives estimates by specific treatment groups.

Table 18: Adjusted relative infringement rates after GLS introduction: by licence level

Offence Type	Licence Level or Group	Adjusted Relative Rate of Infringement Post vs. Pre GLS	Stat. Sig.**	95% Confidence Interval	
				Lower	Upper
All Infringements	L	.570	0.000	.563	.577
	P1	1.110	0.000	1.096	1.124
	P2	.771	0.000	.759	.784
	Open	.809	0.000	.787	.831
Unlicensed/Disqualified	L	.904	0.000	.860	.950
	P1	1.587	0.000	1.477	1.704
	P2	.342	0.000	.316	.370
	Open	.497	0.000	.429	.574
Speeding	L	.606	0.000	.586	.627
	P1	.923	0.000	.908	.938
	P2	.731	0.000	.716	.746
	Open	.953	0.006	.920	.986
Seatbelt	L	.522	0.000	.486	.561
	P1	.813	0.000	.762	.868
	P2	.430	0.000	.394	.469
	Open	.373	0.000	.318	.438
Other	L	.718	0.000	.702	.736
	P1	1.154	0.000	1.122	1.187
	P2	.687	0.000	.661	.713
	Open	.687	0.000	.636	.742
Mobile phone	L	.591	0.000	.488	.716
	P1	.900	0.013	.829	.978
	P2	1.126	0.008	1.031	1.229
	Open	.712	0.000	.602	.840
Hooning	L	1.535	0.345	.631	3.733
	P1	1.693	0.044	1.015	2.823
	P2	.426	0.013	.217	.835
Drink Driving	L	.828	0.000	.781	.879
	P1	3.158	0.000	3.000	3.325
	P2	2.636	0.000	2.473	2.810
	Open	.240	0.000	.208	.277
Disobey Road Signage	L	.758	0.000	.697	.824
	P1	6.252	0.000	5.695	6.863
	P2	.894	0.001	.834	.958
	Open	.968	0.536	.874	1.072

Table 19: Adjusted relative infringement rates after GLS introduction: by specific treatment group

Offence Type	Licence Level or Group	Adjusted Relative Rate of Infringement Post vs. Pre GLS	Stat. Sig.**	95% Confidence Interval	
				Lower	Upper
All Infringements	TG1	.776	0.000	.769	.784
	TG2	1.201	0.000	1.124	1.282
	TG3	1.180	0.000	1.093	1.274
	TG4	1.343	0.000	1.278	1.412
	TG5	.964	0.004	.940	.989
	TG6	.823	0.000	.810	.837
	TG7	.870	0.000	.861	.879
	TG8	1.211	0.000	1.162	1.262
	TG9	.896	0.000	.881	.912
	TG10	.495	0.000	.484	.506
Unlicensed/Disqualified	TG1	.500	0.000	.473	.529
	TG2	.785	0.229	.529	1.165
	TG3	.722	0.181	.448	1.163
	TG4	1.585	0.000	1.250	2.010
	TG5	1.008	0.910	.885	1.147
	TG6	2.359	0.000	2.189	2.541
	TG7	.967	0.214	.916	1.020
	TG8	.963	0.715	.784	1.182
	TG9	.770	0.000	.713	.831
	TG10	.995	0.900	.925	1.072
Speeding	TG1	.865	0.000	.853	.877
	TG2	.919	0.157	.817	1.033
	TG3	.936	0.333	.820	1.070
	TG4	.941	0.193	.859	1.031
	TG5	.728	0.000	.699	.757
	TG6	1.175	0.000	1.126	1.225
	TG7	.809	0.000	.798	.821
	TG8	1.175	0.000	1.110	1.243
	TG9	.737	0.000	.718	.756
	TG10	.564	0.000	.530	.601
Seatbelt	TG1	.560	0.000	.530	.591
	TG2	.448	0.008	.248	.809
	TG3	.383	0.011	.183	.805
	TG4	.486	0.002	.305	.773
	TG5	.462	0.000	.378	.565
	TG6	.498	0.000	.450	.553
	TG7	.659	0.000	.622	.699
	TG8	.745	0.051	.554	1.001
	TG9	.739	0.000	.664	.822
	TG10	.475	0.000	.414	.546
Other	TG1	.815	0.000	.797	.834
	TG2	1.364	0.000	1.205	1.544
	TG3	1.298	0.001	1.120	1.505

	TG4	1.792	0.000	1.636	1.962
	TG5	1.058	0.048	1.001	1.118
	TG6	.920	0.000	.893	.948
	TG7	.880	0.000	.859	.903
	TG8	.986	0.779	.894	1.088
	TG9	1.018	0.366	.980	1.057
	TG10	.531	0.000	.510	.554
Mobile phone	TG1	1.279	0.000	1.203	1.361
	TG2	.818	0.490	.464	1.445
	TG3	.683	0.314	.325	1.435
	TG4	.479	0.002	.301	.763
	TG5	.398	0.000	.328	.484
	TG6	1.528	0.001	1.197	1.951
	TG7	.745	0.000	.696	.796
	TG8	.720	0.041	.525	.987
	TG9	.483	0.000	.430	.543
	TG10	.488	0.000	.337	.708
Hooning	TG1	.688	0.168	.404	1.171
	TG3	4.306	0.155	.575	32.227
	TG4	5.450	0.024	1.250	23.764
	TG5	.463	0.455	.061	3.495
	TG6	.327	0.164	.067	1.581
	TG7	.789	0.403	.453	1.375
	TG8	89.963	0.000	53.059	152.535
	TG9	.253	0.185	.033	1.930
Drink Driving	TG1	1.356	0.000	1.299	1.415
	TG2	5.496	0.000	4.639	6.512
	TG3	4.290	0.000	3.406	5.404
	TG4	3.542	0.000	2.926	4.288
	TG5	4.513	0.000	4.176	4.878
	TG6	2.684	0.000	2.463	2.924
	TG7	2.698	0.000	2.589	2.811
	TG8	4.457	0.000	3.905	5.088
	TG9	4.076	0.000	3.827	4.341
	TG10	.683	0.000	.623	.748
Disobey Road Signage	TG1	1.701	0.000	1.618	1.788
	TG2	1.652	0.017	1.096	2.492
	TG3	2.655	0.000	1.841	3.830
	TG4	2.917	0.000	2.312	3.679
	TG5	2.075	0.000	1.856	2.319
	TG6	1.687	0.000	1.510	1.885
	TG7	1.700	0.000	1.613	1.791
	TG8	2.279	0.000	1.882	2.762
	TG9	1.595	0.000	1.469	1.731
	TG10	.696	0.000	.588	.824

7.3 DISCUSSION

7.3.1 Infringements specific to the new GLS

Without supporting information on the enforcement effort that has been applied to various offence types specific to the new GLS in Queensland, definitive interpretation of the observed infringement numbers in the data is not possible. Observing few or no offences of a particular type could mean either there is perfect or near perfect compliance with the regulation. Alternatively it could mean that either the police are choosing not to enforce the regulation or are unable to enforce the regulation due to technical or resource issues. It is considered unlikely that perfect compliance has been achieved for any regulation specific to the GLS. This is supported by firstly the large number of infringements of all types, particularly non GLS specific, committed by novice drivers both before and after introduction of the new GLS (see Appendix B). The number of infringements even for high compliance regulations such as seatbelt wearing is also large in absolute terms suggesting that the enforcement of road regulations by novice drivers through policing is reasonably vigorous in Queensland. Consequently, low or zero number of GLS specific infringements has been interpreted as representing an unenforceable or difficult to enforce regulation in the following discussion.

The total number of infringements issued for offences relating to specific components of the new GLS was 29,843. Of these the majority were for failure to display L or P plates. Of all the infringements specific to the new GLS it is argued that the failure to display L or P plates is estimated to have one of the weakest correlations to young novice driver crash risk because, as outlined in Section 2.5.8. This GLS component is intended for other road users to be aware that the driver is a novice, to aid enforcement, and to limit novice driver risk-taking. Furthermore there have been no evaluations assessing the effectiveness of this requirement. Therefore this analysis has demonstrated that the type of infringements specific to the GLS that appear to be most amenable to enforcement are likely to be based on a GLS component with very little relationship to crash risk. However, it still may have an indirect effect on crash risk by increasing the likelihood of being detected and punished and therefore, increasing driver compliance. There is some suggestion of this effect evidenced by the reduction in most non GLS specific offences. As will be noted later, it also assists with enforcement of GLS specific regulations such as blood alcohol laws. It is also possible that police might be stricter on enforcement of P-platers when they see non-compliance. Therefore, this initiative may well have a significant influence/relationship on crash risk but through indirect means (in areas where enforcement is present).

It is also somewhat curious that failure to display L or P plates is the most predominant in the data since as an offence on its own it would seem relatively difficult to enforce. A police officer would be required to visually estimate the age of the driver and then intercept them on suspicion of being on an L or P license. Automated enforcement would also be unable to cover this regulation. Its high prevalence is more likely a result of this offence often being detected at the time of interception for a different type of offence. Interrogation of the offence data confirms this to be the case. This is also consistent with the hypothesis that novice drivers may choose to remove L or P plates when they have the intention of committing other offences such as unaccompanied learning or drink driving in an effort to avoid detection. Validation of this hypothesis would require further specific research.

The next two most commonly issued infringements were breaches of the peer passenger restriction and breach of the late night driving penalty[1]. Considering the association with crash risk (see Section 2.5.9) it is encouraging that breaches of the peer passenger restriction were the third-highest category of infringements recorded. The late night driving penalty however indicates that an already high-risk group of drivers (those who have received a suspended or cancelled licence) continue to be high risk by breaching the late-night driving requirement. The significant number of both these infringement types recorded suggests it is feasible for police to enforce these regulations and that they have been doing so with diligence.

The remaining categories indicated that very few (or no) infringements were issued for the mobile phone restriction (for both drivers and supervisors[2]/passengers), logbook requirement (for either Learners or their supervisors[3]), or the high-powered vehicle restriction. As noted, it is possible that the low numbers of infringements issued for these GLS components are due to high compliance but it is more likely that these components are either not being enforced or are very difficult to enforce. Previous research indicates that it is difficult to enforce the logbook requirement (Palamara, 2007) and mobile phone restrictions (Foss et al., 2009). It is unclear the extent to which these restrictions are adhered to due to the existence of the law - that is, the level of deterrence based on driver's perceptions of being detected. This would also require further specific research to understand.

For the logbook requirement there were no infringements issued in the extract from the TRAILS database. However there were 20 infringements, including infringements issued to supervisors, issued by the logbook department that receives and checks the logbooks within the Department of Transport and Main Roads between 1 July 2007 and 30 September 2012. The check of the Learner logbook is as follows: Learners lodge their logbooks and these are checked by the Department of Transport and Main Roads which results in the logbook either being accepted or rejected. If the logbook is rejected the Learner can either choose to rectify the logbook and resubmit or if they insist that it is correct, then the Department of Transport and Main Roads deem it as "failed' and the matter is handled by the prosecutions area. It is possible however that the prosecutions area do not record the offence as a log book infringement but instead code it under the more general category of falsifying documents which masks the true logbook infringement rates. Internal coding practises potentially need to be reviewed in relation to logbook offences if a clear picture of the rate of this offence is to be gained. Between the years 2008 – October 2012 over 80% of logbooks submitted were accepted, whereas in 2007 this figure was only 50%. Assuming that the criteria for logbook acceptance have not changed and that drivers have not become more adept at

[1] Imposed upon drivers who have their licence suspended as a result of demerit points or a high speed offence, or they select a Good Driving Behaviour period AND they committed the offence that led to the notice to choose or suspension after 30 June 2007 AND the person was under 25 years at the time of committing the offence AND they held a P type, P1 type, P2 type or did not hold a valid driver licence and were not eligible for an open licence OR the person was disqualified by a court for an offence committed after 30 June 2007 and they committed the offence when they were under 25 years (personal communication, Michael Skinner, Department of Transport and Main Roads, 9 June 2010).

[2] It was later clarified by the Data Analysis Unit at the Department of Transport and Main Roads that infringements for supervisors would be unlikely to be included in the data extract of infringements because the data request only related to novice drivers and drivers aged between 25-35.

[3] As above.

falsifying log books over the period, this suggests that compliance with the regulation is increasing over time.

The proportion of total offences issued to novice drivers over the study period shown in Table 16 that were GLS specific was less than 1% although it should be noted that this includes non GLS specific infringements issued before the new GLS was introduced. Considering that the post GLS period represents somewhere over half of the total infringement, this still means that less than 2% of all infringements are GLS specific. This is likely to indicate a reasonably high compliance with the new GLS regulations compared to nonspecific offences such as drink driving and speed which predominate in the novice driver offence data. However it also suggests that many of the key GLS related regulations are difficult to enforce which is also suggested elsewhere in the literature. Further research is clearly required to specifically examine novice driver compliance with new GLS regulations through either survey based methods or naturalistic driving study methods, the former likely being more efficient, the latter less susceptible to reporting bias.

7.3.2 Infringements not specific to the new GLS

Analysis of infringements not specifically related to GLS requirement is presented in Tables 17, 18 and 19. The vast majority of the analysis results presented reached statistical significance, reflecting the large numbers of infringements by novice drivers. Only a few selected results relating to hooning and unlicensed or disqualified driving were not statistically significant reflecting the relative rarity of these two serious offence types. Appendix B shows that the most common offences for which novice drivers were detected were speeding and drink driving with the other offences group (a mix of a range of miscellaneous offences) also being highly represented.

Overall, introduction of the new GLS has been associated with the drop in the relative rate of offence notices issued to novice drivers. Table 17 shows a 5.7% net reduction in offence rates when considering the novice driver population as a whole regardless of passage through phases of the new GLS. When considering only novice drivers who have gone through some element of the new GLS, the net reduction in rate of offences was 20.2%. The difference between the two results suggests that those who have gone through some element of the new GLS are more compliant with the regulations.

Examination of the overall net offence rate changes after the new GLS introduction reveals reductions in the rate of the majority of offence types, the largest reductions being observed for unaccompanied learning and seatbelt offences. The most notable exception to this is drink driving offences which showed a statistically significant net increase. Examination of Table 18 giving results by licence class shows the increases in drink driving offences stemmed entirely from the P1 and P2 licence classes. Explaining the likely reason for this increase is difficult since the requirement of zero BAC for provisionally licensed drivers was carried over from the old GLS and was not a new feature of the new GLS. The most likely explanation for the apparent increase is the requirement to display P plates. For random breath test operations particularly where licence production is rarely demanded, P plates on a vehicle immediately identify the requirement of the zero BAC level for the driver. Without P plates it is likely that the police did not reliably prosecute provisionally licensed drivers with BACs under 0.05 since they had no way of identifying their licence status and hence treated them like a fully licensed driver. It is likely that the requirement to display P plates is also linked to the measured drops in other offences such as mobile phone use as it immediately

identifies the provisionally licensed driver to police and hence the associated driving requirements.

Further understanding of the alcohol infringement result can be gained by examining the distribution in blood alcohol levels of drivers involved in crashes by licence type and GLS period. This data is shown in Table 20 for the drivers used in the primary evaluation of crash outcomes. It shows the proportion of P drivers who test positive for blood alcohol in a crash has dropped since the introduction of the new GLS compared to a slight increase in the control group. These drops were statistically significant for both the P1 drivers ($\chi^2(1)=124$, $p<0.001$) and P2 drivers ($\chi^2(1)=29.6$, $p<0.001$). The largest reductions for P drivers have been in the 0.01-0.04 range, particularly for P2 drivers, the range which would have been difficult to enforce previously without the requirement to display identifying P plates. This result suggest the increase in blood alcohol infringements observed for P drivers post introduction of the new GLS is not an indication of increased alcohol exposure amongst P drivers. Instead, it suggests alcohol enforcement of P drivers has become more efficient leading to a reduction in the proportion of crash involved P drivers with positive blood alcohol reading, particularly in the sub 0.05 range. This is likely to be, at least in part, a result of the mandatory requirement under the new GLS to display P plates which allows police to identify novice drivers in random breath testing operations and hence enforce the zero alcohol requirements for novice drivers.

Table 20: Distribution of crash involved driver blood alcohol levels by licence types and GLS period

	Pre New GLS			Post New GLS		
BAC Range	**Comparison**	**P Yr 1**	**P Yr 2**	**Comparison**	**P1**	**P2**
0.01 - 0.04	1.37%	1.13%	1.00%	1.99%	0.83%	0.37%
0.05 - 0.09	1.87%	1.85%	2.17%	2.17%	1.58%	1.86%
0.10 - 0.14	2.90%	2.64%	3.36%	2.75%	1.83%	2.88%
0.15 - 0.19	2.66%	1.39%	2.51%	2.87%	1.10%	1.67%
0.20 - 0.24	1.25%	0.55%	0.61%	1.48%	0.38%	0.28%
0.25 and over	0.42%	0.05%	0.10%	0.36%	0.10%	0.09%
Over Limit	9.09%	7.60%	9.74%	9.63%	5.81%	7.14%
Nil	89.12%	92.16%	89.97%	88.39%	94.19%	92.86%

Examination of net offence changes by licence type in Table 19 shows the general reduction in offences was uniform for all licence levels except for P1 drivers where a statistically significant 11% increase was recorded. This increase stemmed from large increases in infringements for P1 drivers detected for unlicensed driving, drink driving, hooning, disobeying road signs and other miscellaneous offences. P2 drivers also recorded increased detection rates of drink-driving and were the only group to show net increased rates of detected mobile phone use. These results point to a greater efficiency of enforcement of P drivers but also a potential need for greater education and even more stringent enforcement of these key identified problems for P1 and P2 drivers.

Examination of net changes in infringement rates by novice driver treatment group show some differential patterns in offences by different paths through the new GLS. TG2-4 and TG8 all showed net increases in infringement rates overall. There are GLS groups that progress to the P1 licence phase at 23 years or above and hence have

different restrictions and licence phase minimum times. Some missing certain licence phases all together. These groups had notable increases in hooning, drink driving, disobeying signs, and other general offences, the majority of these offences for serious high risk behaviours. These results suggest that the exemption of certain GLS conditions for these older groups of novice drivers may not be warranted.

TG1 is of particular interest in the analysis as these represent the majority of drivers who will progress through the new GLS in the future. Encouragingly this group recorded one of the biggest net reductions in offence rates. Reductions were recorded in most specific offence types apart from disobeying road signs, mobile phone use and drink driving although their net increase in drink driving was the second smallest of any group. This further illustrates the need for more efficient means of enforcing mobile phone use.

Further specific research on police enforcement practices is warranted to understand exactly how GLS elements such displaying P plates have assisted in effective enforcement. Further survey or interview based research on novice drivers may also assist in understanding the deterrent mechanism each GLS element has had on various infringement types observed to have changed substantially in this research.

7.4 CONCLUSIONS

Analysis of novice driver infringement rates from before to after introduction of the new GLS against similar trends in infringements amongst experienced drivers has identified a number of changes in novice driver infringement patterns associated with the new GLS introduction. It has also helped illuminate the potential effectiveness of elements of the new GLS by looking at the prevalence of infringements related specifically to new licensing conditions introduced under the new GLS.

The total number of offences detected related to new GLS driving conditions is very small as a proportion of the overall novice driver offence pool. This potentially suggests that novice drivers are relatively compliant with the new GLS regulations but more likely suggests that the intensity of enforcing GLS restrictions is not particularly high. Results show that enforcement of P plate display, peer passenger rules and late night driving curfews by police is feasible, particularly when drivers are intercepted for other infringements. In contrast enforcement of the mobile phone rules, particularly related to supervisors and passengers, does not appear to be feasible. Enforcement of the log book requirements also appears to be very lenient.

Overall, introduction of the new GLS has been associated with a net reduction in the rate of offences by novice drivers. The exception to this is drink-driving where rates of offences have increased dramatically. This appears not to be due to the prevalence of drink driving amongst the novice driver population increasing, as evidenced by reduced alcohol involvement in crashes, but because of an increase in the ability of the police to detect zero BAC breaches for provisionally licensed drivers due to them being readily identified with P plates. P1 drivers were the only licence class to record an overall net increase in the rate of offending driven by increases in unlicensed driving, hooning, drink driving and disobeying road signs. Older novice drivers who do not have to comply with all aspect of the new GLS also showed increases in their net rate of a number of serious offence types including hooning, drink driving and disobeying road signs. Importantly, those who progressed through all phases of the new GLS, representing the largest group of future novice drivers, recorded one of the largest

decreases in overall offence rates and one of the smallest net increases in drink driving offences. Mobile phone offences were the only standout problem for this group.

8 SECONDARY EVALUATION: PEER PASSENGER RESTRICTIONS

8.1 INTRODUCTION, DESIGN CONSIDERATIONS AND AIMS

Under the new Queensland GLS, drivers on a P1 licence are subject to a peer passenger restriction. According to the definitions the peer passenger restriction is defined as:

> Only one passenger under 21 years of age (excluding immediate family members) may travel with you between 11pm on a day and 5am on the next day. Section 74 of the Transport Operations (Road Use Management– Driver Licensing) Regulation 2010 defines an immediate family member of the driver as:
>
> - the driver's spouse
> - a child, step-child, foster child, or ward of the driver
> - a step-parent of the driver
> - the spouse of a grandparent of the driver
> - a brother or sister of the driver
> - a stepbrother or stepsister of the driver
> - a foster child or ward of a parent or step-parent of the driver
> - if the driver is a child
>   - an approved carer of the driver
>   - a child, step-child, foster child or ward of an approved carer of the driver
> - a guardian of the driver
> - a child, stepchild, foster child, or ward of a guardian of the driver.

As noted in Section 2.5.9, the primary aim of the peer passenger restriction is to reduce the risk of crash involvement to both the novice driver and their peer passengers. There are two key mechanisms of trauma reduction hypothesised to result from the restriction. The first is a reduction in crash risk potentially stemming from the removal of distractions or peer pressure effects to engage in high risk behaviour associated with multiple peer passengers. The second is to limit the person exposure per novice driver vehicle at high risk times meaning in the event of a crash the potential number of injuries is reduced due to reduced occupancy. This is why the Queensland peer passenger restriction is applied in late night and early morning hours where crash risk is known to be highest.

One way to evaluate the effects of peer passenger restrictions would be to establish the crash risk associated with carriage or more than one peer passenger relative to the carriage of one or less peer passengers during the hours 11pm to 5am in the period prior to the introduction of the new GLS. The reduction in the rate of novice drivers crashing with 2 or more peer passengers from before to after introduction of the new GLS could then be used in combination with the estimated relative risk to determine the net crash savings due to the regulation (in a similar way to the high powered vehicle restriction analysis undertaken in Section 9). There are two problems with this approach related to the measurement of crash risk associated with peer passenger carriage. First, there is no available measure of exposure of peer passenger carriage by available novice drivers. Second, occupants other than the vehicle controller are only recorded in Queensland police reported crash data if they are injured. Hence the presence of peer passengers in crashes can only be determined for injured peer passengers. Finally, there is no way to identify if injured peer passengers

are immediate family members of the novice driver given the information available in the crash data.

Acknowledging these limitations, a two-stage approach was taken to the evaluation of the peer passenger restrictions in the new Queensland GLS. The first stage examined the proportion of police reported crashes involving first year provisionally licensed drivers occurring in the hours to which peer passenger restrictions apply (11pm-5am) and how this has changed with the introduction of the new GLS. Analysis of the proportion rather than number of crashes in the peer passenger restriction time inherently controls for differing number of licensed drivers over time. It also adjusts for general changes in travel exposure by novice drivers and changes in risk due to other GLS components through the use of the total crash count in the denominator of the proportion. A comparison group in the form of crashes involving second year provisionally licensed drivers was also included in the analysis to represent any general trends in relative novice driver exposure to peer restricted driving times. Second year provisionally licensed drivers were chosen as the comparison since they were likely to be similar in behaviour and lifestyle but were not subject to the peer passenger restriction.

The second phase of the analysis aimed to examine the prevalence of injured peer passengers in first year provisionally licensed driver vehicles crashed during the hours of peer passenger restrictions. It was hypothesised that a change in the proportion of vehicles crashed with injured peer occupants is reflective of the relative occupancy rate of peer passengers in first year provisionally licensed driver crashed vehicles, assuming the injury rate per crash is proportionate to the occupancy rate. The primary focus of the analysis was the proportion of crashed vehicles where two or more peer passengers were injured since these are crashes where the peer passenger restrictions may have been breached (apart from those crashes involving immediate family members being injured since these could not be identified). The proportion of crashed vehicles with one injured peer passenger were also analysed for comparison. The same second year provisionally licensed driver group was used as a comparison group in this analysis to control for any general trends in injured peer passenger occupancy rates not related to the peer passenger restriction.

8.2 DATA AND METHODS

The crash data used for the Primary Evaluation was again used for the peer passenger analysis including the labelling of first and second year provisionally licensed drivers in the period prior to the new GLS and P1 and P2 drivers in the period after introduction of the new GLS. Information on casualties in each crashed vehicle was used to identify the number of casualties aged less than 21 years in each vehicle in each crash (the peer passengers for novice drivers). This information was merged onto the Primary Evaluation crash data set to identify those vehicles with no injured peer passengers as well as the licence status of the novice driver at the time of the crash.

For first and second year provisionally licensed drivers in the period prior to the new GLS and P1 and P2 drivers in the period after introduction of the new GLS the following summary information was assembled:

- Total number of vehicles crashed
- The number of vehicles crashed between the hours of 11pm and 5am
- The number of vehicles crashed between the hours of 11pm and 5am where one or more passenger under the age of 21 was injured

- The number of vehicles crashed between the hours of 11pm and 5am where two or more passenger under the age of 21 was injured

Data was summarised for all police reported crashes only since there was insufficient crash numbers to undertake the analysis by specific crash or injury severity levels. Summary data was assembled for the period before (July 2004 – June 2007) and after (July 2007 – December 2009) the introduction of the new GLS.

Separate binary logistic regression analysis models were used to assess:

- The change in odds of a P1 or first year provisionally licensed driver crash being in the hours 11pm to 5am from pre to post new GLS introduction relative to changes in P2 or second year provisionally licensed drivers over the same time period (risk analysis)
- The change in odds of a P1 or first year provisionally licensed driver crash in the hours 11pm to 5am resulting in 1 or more injured passengers under 21 years old from pre to post new GLS introduction relative to changes in P2 or second year provisionally licensed drivers over the same time period for crashes (occupancy analysis 1)
- The change in odds of a P1 or first year provisionally licensed driver crash in the hours 11pm to 5am resulting in 2 or more injured passengers under 21 years old from pre to post new GLS introduction relative to changes in P2 or second year provisionally licensed drivers over the same time period for crashes (occupancy analysis 2)

All analyses were conducted in SPSS Version 20.

8.3 RESULTS

Table 1 shows the data used to conduct the risk analysis along with the estimated net change in the odds of a first year provisionally licensed driver crash occurring during the hours 11pm-5am, relative to the second year provisionally licensed comparison group and its statistical significance. It shows that the proportion of crashes occurring in times of peer passenger restrictions has fallen in the order of 20% for both P1 and P2 drivers meaning there is no net difference in the before to after change between the P1 and P2 groups (OR=1.033, stat. sig. = 0.81). Given the assumptions underlying the analysis design hold, results of this analysis imply the peer passenger restrictions imposed on P1 drivers under the new GLS have had little effect on crash risk in the times the restrictions apply.

Table 21: Analysis of change in crash risk during peer passenger restriction hours

Study Group	GLS Period	All Crashed Vehicles	Vehicles Crashed 11pm-5am	%Vehicles Crashed 11pm-5am
Pre GLS Year 2 P Drivers	Before	6434	608	9.45%
Post GLS P2 Drivers	After	1130	86	7.61%
Pre GLS Year 1 P Drivers	Before	6287	653	11.59%
Post GLS P1 Drivers	After	4735	409	9.45%
Net Relative Risk (post vs. pre GLS)				1.033
Statistical Significance				0.81

Table 22 summarises the data used for the analysis of peer passenger injury rates in crashes during times of peer passenger restrictions and the results of the logistic regression analysis. Comparing raw rates of peer passenger injuries in cars crashed by first year P drivers from before to after the introduction of the new GLS in injury showed a 20% increase in the rate of crashes with one or more peer passenger injuries and a 66% increase in the percentage of crashes with 2 or more peer passenger injuries. The corresponding changes in the P2 comparison group were an 18% decrease and a 6% increase. This translates to a net increase after introduction of the new GLS in the odds of a peer passenger injury in cars crashed by first year P drivers of 53% and 60% for one or more and two or more peer passenger injuries respectively. However, the logistic regression analysis showed that neither of the estimated net increases was statistically significant reflecting the relatively small absolute number of crashes in times of peer passenger restriction that involve peer passenger injury (see Table 22).

Table 22: Analysis of change in risk of multiple peer passenger injuries in crashes during peer passenger restriction times

Study Group	GLS Period	All Crashed vehicles	Crashed With 1 or More Injured Peer Pass.	Crashed With 2 or More Injured Peer Pass.	Rate Crashed With 1 or More Injured Peer Pass.	Rate Crashed With 2 or More Injured Peer Pass.
Pre GLS Year 2 P Drivers	Before	608	60	20	9.87%	3.29%
Post GLS P2 Drivers	After	86	7	3	8.14%	3.49%
Pre GLS Year 1 P Drivers	Before	653	92	24	14.09%	3.68%
Post GLS P1 Drivers	After	409	69	25	16.87%	6.11%
Net Relative Risk (post vs. pre GLS)					1.529	1.606
Statistical Significance					.347	.496

8.4 DISCUSSION

This section of the evaluation of the new Queensland GLS has attempted to measure the effects of the peer passenger restriction component of the GLS on both crash risk during the times the restrictions apply as well as the rates of injured peer passengers in cars crashed by first year provisionally licensed drivers. As noted, the evaluation design was compromised by limitations in the data available to support the evaluation. The primary data limitation is the lack of a measure of travel by novice drivers by times of day and, more specifically, the amount of travel with various numbers of peer passengers in the vehicle. Access to such data would allow the direct estimation of crash risk associated with peer passenger carriage by novice drivers that could be combined with the exposure data to estimate the benefits of the peer passenger restrictions. Access to this type of data is lacking in most jurisdictions and previous evaluations of peer passenger restrictions as part of a GLS have also suffered this limitation.

Analysis of the proportion of crashes in times where peer passenger carriage is restricted is an attempt to use a type of induced exposure methodology which uses a proxy for the unavailable exposure measure. In this case, the number of crashes in non-restricted times is the measure of induced exposure in terms of the number of licensed drivers and their total travel. Use of induced exposure methodology is common in road safety where a direct measure of exposure is not available. Using this approach assumes that the ratio of

restricted time crashes to non-restricted time crashes in the period prior to the GLS is representative of what would be expected in the post period without the peer passenger restriction in place. The simple before to after comparison for first year provisionally licensed drivers in Table 21 shows a 21% reduction in the odds of a crash occurring in the restricted times. Taking this as a measure of the peer passenger restriction assumes that all the other components of the GLS introduced and applying specifically to P1 drivers affect crash risk equally at all times of the day. It might be expected that mobile phone restrictions and high powered vehicle restrictions would have uniform influence over time of day although this is not known for sure. Even though a zero blood alcohol requirement was in place for novice drivers before the new GLS, it has been shown in the analysis of infringements that alcohol enforcement under the new GLS is more effective for P1 drivers most likely due to the requirement to display P plates. This is one GLS component that is likely to have differential effects on crash risk by time of day, with potentially greater effects at the times peer passenger restrictions are in place. For this reason, it is likely that a simple before to after comparison of peer passenger restriction time crash proportions for first year provisionally licensed drivers is not a pure measure of the crash risk reduction associated with the peer passenger restriction.

To account for the potential confounding of changes in alcohol enforcement effectiveness and other GLS initiatives, a comparison group was introduced into the analysis. P2 drivers were considered the most appropriate comparison group since they are similar in age and the only major difference in P2 and P1 restrictions under the new GLS is the peer passenger restriction for P1 drivers. Examination of the change in the odds of a P2 driver crashing in times of peer passenger restrictions for P1 drivers showed and almost identical 20% reduction. Using the P2 drivers to control the estimates of peer passenger crash risk effects in the P1 group led to the analysis estimating no net effect of the peer passenger restriction in P1 driver crash risk. Assuming the non-restricted time crashes to be adequately representing exposure in both the P1 and P2 groups, results of the analysis suggest that the peer passenger restriction has had little effect on crash rate. Based on the results of the infringement analysis it seems likely that the large reductions in the risk of late night crashes for both P1 and P2 drivers are the result of more effective enforcement of the zero blood alcohol requirement applying to both groups.

Although not statistically significant, the increase in the rate of peer passenger injuries in cars crashed by P1 drivers after introduction of the new GLS shown in Table 22 is some cause for concern. Analysis of infringement data also showed 2720 infringements issued for peer passenger violations suggesting far from 100% compliance with the regulation. Both these results suggest that compliance with the peer passenger regulation need continued monitoring and potentially additional enforcement considered.

Interpretation of the data in Table 22 also provides some insight into the potential influence of the peer passenger restrictions for P1 drivers. Assuming that each occupant of a vehicle is equally likely to be injured in the event of a crash, the data in Table 22 gives some indication of the actual rates of P1 drivers carrying two or more peer passengers. It suggests the rate of exposure is generally well under 10% with the rate of carriage of even 1 passenger likely to be under 20%. Crashes during the peer passenger restriction hours of 11pm-5am represent only around 10% of all P1 driver crashes. Combining these two measures suggests that 100% effectiveness of and 100% compliance with the current Queensland peer passenger restriction would result in an overall crash reduction for novice drivers of only 1%.

8.5 CONCLUSION

Evaluation of the effectiveness of peer passenger restrictions for P1 drivers during the hours of 11pm-5am has been unable to establish any statistically significant effects of the restrictions on crash involvement and overall passenger injury rates for crashes involving P1 drivers. Although the analysis estimated a 20% reduction in crash risk for P1 drivers during the hours of 11pm-5am, a similar reduction was also estimated for P2 drivers who are not subject to the restriction. This in combination with analysis of infringement data and alcohol involvement in night time crashes suggests the majority of the reduction might have been attributable to more efficient enforcement of the requirement for zero blood alcohol and not the peer passenger restriction. Data also suggest that compliance with peer passenger restrictions may be relatively poor. Collection of travel and exposure data specific to the peer passenger restrictions would allow more definitive evaluation of this component of the new GLS.

9 SECONDARY EVALUATION: HIGH-POWERED VEHICLE RESTRICTION EVALUATION

9.1 INTRODUCTION AND METHOD

9.1.1 Aims and experimental design

The purpose of this project was to undertake an assessment of the high powered vehicle restrictions in terms of their effects on novice driver crash risk and injury outcomes. The analysis is in two main sections. Firstly, the effects on fleet secondary safety (crashworthiness, aggressivity and total safety) associated with the restricted vehicles regulation were analysed. Secondly, the change in prevalence of the restricted vehicles was estimated, leading to an estimate of the change in crash involvement risk and injury rate associated with the regulation.

9.1.2 Methods

9.1.2.1 Crash data

The data used in this analysis was from the extract of police-reported crash data as provided by the Department of Transport and Main Roads (TMR) for the Primary Evaluation (see Section 3.3.4). Due to the varying time periods of data available by crash severity most of the analyses were conducted for the period 1 July 2004 to 31 December 2009, for which all severity levels of crash data were available. This was carried out in order to avoid interpretation issues that can arise when the data are pooled and analysed as a time series.

9.1.2.2 Classifying restricted vehicles

In Queensland high powered vehicle restrictions currently apply only to P-plated drivers under 25 years of age. Restricted vehicles are defined to be those with one or more of the following characteristics: an engine with eight cylinders or more; an engine that is turbocharged or supercharged (except diesel vehicles or specified lower performance vehicles); an engine that has been modified subsequent to manufacture to increase performance; particular nominated high performance six cylinder engines; an engine that has a power output of more than 200 kW; a rotary engine that has an engine capacity of more than 1146cc.

The vehicles subject to a restriction in Queensland were identified in the crash data described above from descriptions of the makes and models, year of manufacture and Vehicle Identification Numbers (VINs). VINs are unique 17-digit serial numbers used by the automotive industry to identify individual vehicles along with coded information on make, model, etc. The 8th digit commonly identifies the engine type whenever there is more than one engine choice for the given make/model/year of manufacture combination. This information was important for discriminating higher performance variants from lower performance vehicles of the same make, model and year of manufacture. To identify other potentially high performance vehicles, a field that stated the engine's number of cylinders was used. Where this identified an 8-cylinder engine, the vehicle was classed as restricted. Table 23 shows that almost two-thirds of the fleet were not able to be classified. The proportion of the crash fleet that are defined as high powered should be regarded as being within the range 4.0% -10.6% (the lower limit being the number of vehicles classified as high powered as a proportion of the entire fleet, the upper being the number of vehicles as a proportion just of the fleet able to be classified). As it is likely that the majority of high powered vehicles were identified using the VIN numbers and/or the number of cylinders,

the proportion of these vehicles in the fleet is likely to be closer to 4% than to the upper limit of this range. Also shown in the table is a breakdown for the high powered vehicles according to the method used to identify them. Most were identified by the VIN numbers, but a significant proportion were identified "classified restricted by V8 only", meaning that they were not classifiable by the VIN number (either because that number was missing/incomplete, or the information was not available to show the characteristics of the vehicle) and were instead classified as high powered by the field in the crash data that stated that the engine had 8 cylinders.

Table 23- ***Numbers of light vehicles in the crash fleet analysed according to whether the vehicle was able to be classified or not as high powered; also these numbers as a proportion of the entire fleet (column 3) and just as a proportion of those vehicles able to be classified (column 4).***

	n	% of fleet	% of those classified
Not classified	128,276	62.6%	-
Classified but not restricted	68,384	33.4%	89.4%
Total classified as restricted	8,122	4.0%	10.6%
- *classified restricted by V8 only*	*3,681*	*1.8%*	*4.8%*
- *classified restricted by VIN*	*4,440*	*2.2%*	*5.8%*
Total crashed light vehicles	204,781	100.0%	-

9.1.2.3 Classifying vehicles by market group

Each make and model grouping are also classified into one of 10 market groups for analysis, consisting of five passenger car classes, three classes of 4WD vehicles (also known as Sport Utility Vehicles), and two classes of light commercial vehicles: Light (passenger car, hatch, sedan, coupe or convertible 3 or 4 cylinder engine, up to 1,500 cc.); Small (passenger car, hatch, sedan, wagon, coupe or convertible 4 cylinder engine, 1,501 cc - 1,900 cc); Medium (passenger car, hatch, sedan, wagon, coupe or convertible 4 cylinder engine, 1,901 cc upward); Large (passenger car, hatch, sedan, wagon, coupe or convertible 6 or 8 cylinder engine); People Movers (seating capacity > 5 people); 4WD Compact (<1700kg tare mass), 4WD Medium (1700kg-2000kg tare mass) and 4WD Large (>2000kg tare mass); Van; and Utility Vehicles (utes).

9.1.2.4 Allocating secondary safety ratings to the Queensland crash fleet

There are a number of resolutions at which vehicle secondary safety rating information can be linked to light passenger and light commercial vehicles appearing in the Queensland crash fleet. They are (in descending order of specificity):

- By specific make and model
- By year of manufacture and market group
- By year of manufacture only

Table 24 shows coverage of the crash fleet as recorded by police over the period. It shows that around 55% of the fleet were able to have all three ratings applied by make and model. The 10% of vehicles without a crashworthiness rating or a Total Safety Index were all vehicles with insufficient VIN and make/model details that additionally had no year of manufacture. The 35% of vehicles with missing aggressivity ratings were those with insufficient VIN and make/model details (unlike crashworthiness and Total Safety, aggressivity does not have a strong relationship to year of manufacture, so linking vehicles to average aggressivity per year of manufacture is not a useful way of estimating aggressivity).

Table 24 - Level of assigning crashworthiness, aggressivity and Total Safety Index (TSI) to light vehicles in the Queensland crash fleet (vehicles involved in all crash data from 1 July 2004 through to 31 December 2009, additionally hospitalisation crash data through to 30 June 2010 and fatal crash data for 2011)

Level of Identification	Method	crashworthiness	aggressivity	TSI
1	Make/model direct	54%	55%	55%
2	Market group and year of manufacture	10%	10%	10%
3	Year of manufacture	25%	0%	25%
4	Not allocated rating	10%	35%	10%

9.1.2.5 Definitions of secondary safety

The overall protection from injury provided by light passenger vehicles in the event of a crash, incorporating both the protection for the vehicle's own occupants and the liability of the vehicle to impose harm on other road users, is known as *secondary* safety. Various systems for rating secondary safety of particular makes and models of vehicles have been developed internationally. These measures generally evaluate **crashworthiness** (the ability of the vehicle to protect its own occupants in the event of a crash) separately from **aggressivity** (the harm a vehicle is liable to impose on other road users into which it crashes). A third measure has been developed by MUARC to combine these two facets of secondary safety into one **Total Secondary Safety Index** estimated from real world crash outcomes (Newstead et al, 2011). It measures the average risk of death or serious injury in crashes involving a light passenger vehicle across all key participants in the crashes, weighted again by the relative crash involvement of each participant type across the entire crash population. It can be estimated for individual vehicle models, by vehicle market groups or for the fleet as a whole as desired.

9.2 RESULTS

9.2.1 Changes in secondary safety associated with vehicle restrictions

The following graphs track the secondary safety of the crash fleets over the three years preceding the introduction of the regulation and the two-and-a-half years following. As described above, the vehicles were allocated ratings at various levels of specificity (see Table 24). Where a value of secondary safety was not able to be allocated, the vehicle was presumed to have the average value for the particular point of the graph (i.e. the average for the relevant grouping of vehicles). Figure 6 shows these estimates for the entire fleet, with each point representing vehicles that crashed in Queensland within the period stated (each point represents a year: 1 July to 31 June, apart from the last point, which represents six months). This shows generally improving crashworthiness, quite flat aggressivity (with a hint of worsening aggressivity from mid-2006 onwards) and Total Safety generally improving, but not as quickly as crashworthiness (note that Total Safety is a weighted average of crashworthiness and aggressivity, as described in detail above, with most weight being placed on crashworthiness).

Figure 7 shows the same estimates, but this time just for those vehicles crashed by drivers on their Learner licence. These show generally improving crashworthiness. Crashworthiness and Total Safety are both poorer than the overall averages shown in the previous figure, although aggressivity is generally better, likely to be related to smaller cars being used by this group of drivers.

Figure 8 shows these estimates for drivers on their Provisional licences who were aged under 25 (and hence subject to the high powered vehicle restrictions subsequent to the introduction of the regulation, again marked by the vertical line). These show generally similar patterns to the previous figure.

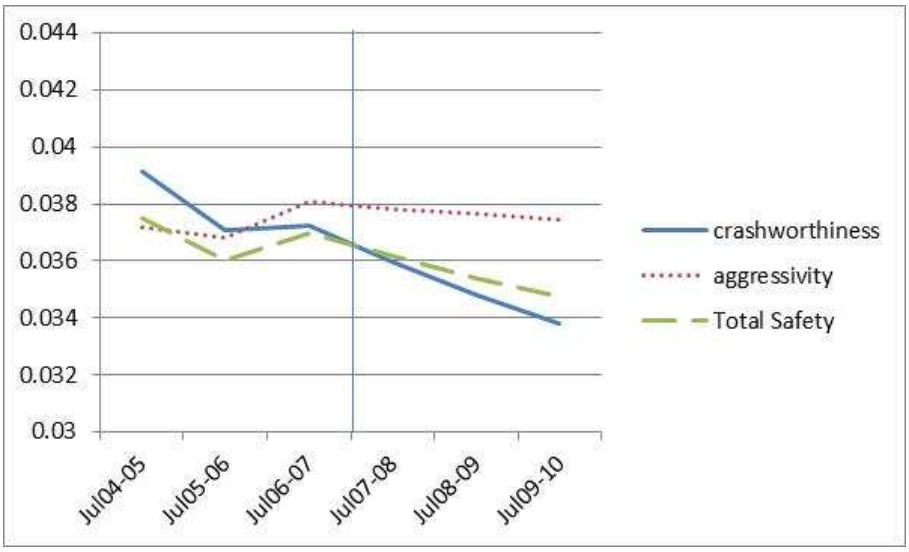


Figure 6 - secondary safety of the *entire* Queensland crash fleet over the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

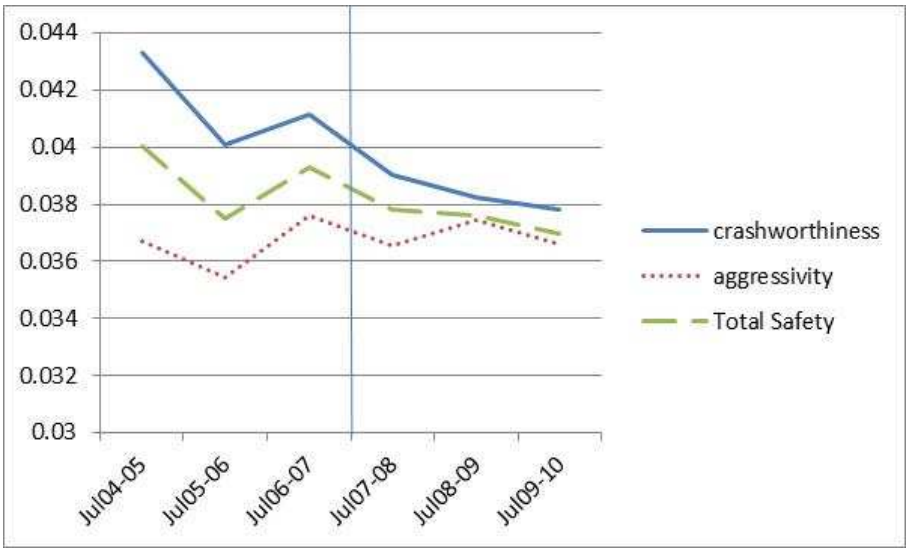


Figure 7 - secondary safety of the *Learner* driver crash fleet over the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

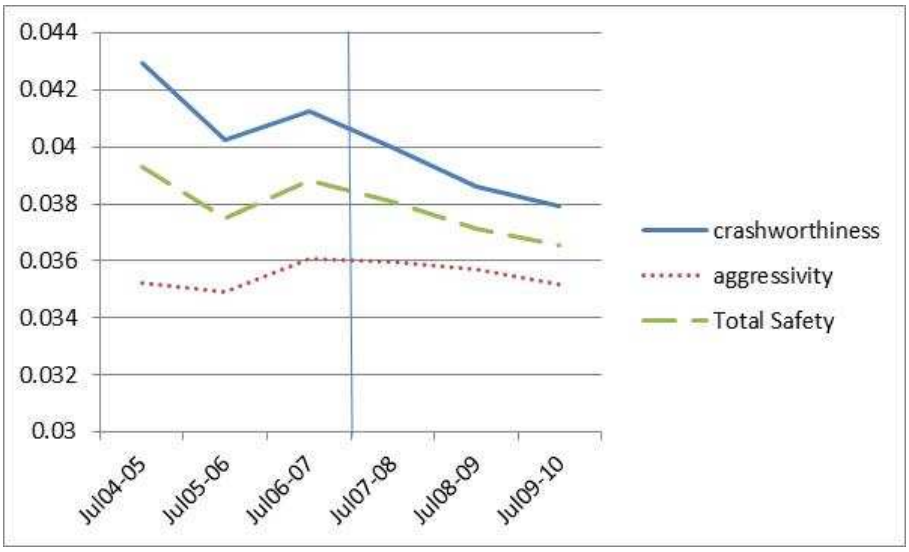


Figure 8 - secondary safety of the *Provisional* driver crash fleet *for drivers aged under 25* over the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

To give an indiction of any potential differeces in trends, particularly changes that might be associated with the introduction of high powered vehicle restrictions, the estimates in the previous figures were combined by dividing the respective rating for one licensing group by that for another. In particular, we were interested in whether the secondary safety ratings of the crash fleet of the Provisional licensed drivers aged under 25 (those affected by this regulation) might be affected relative to the way a comparible fleet of vehicles was changing. Therefore, the ratings for this group are presented, divided by ratings of various comparison crash fleets (adjacent age groups and Learner licencees).

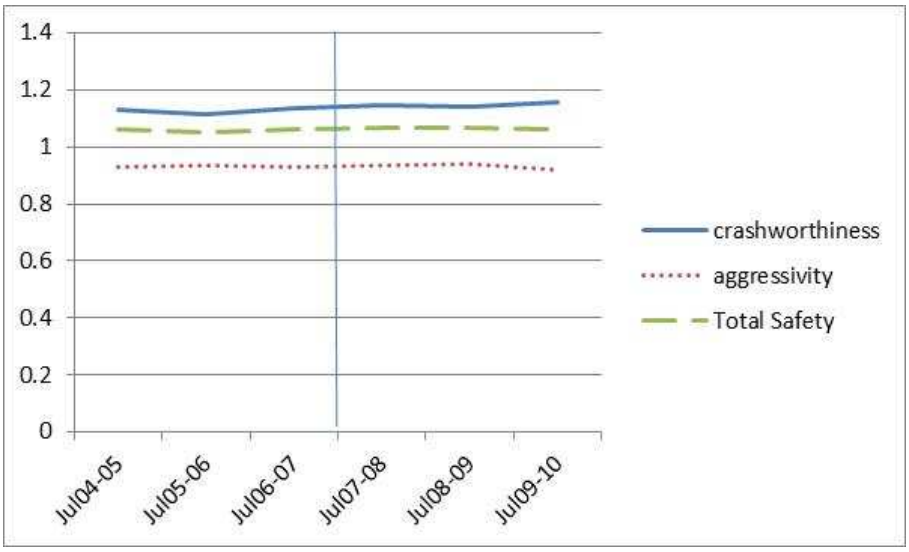


Figure 9 – Relative secondary safety of the Provisional driver crash fleet for drivers aged under 25 relative to the ratings for drivers on their *full licence aged 25- 35* over the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

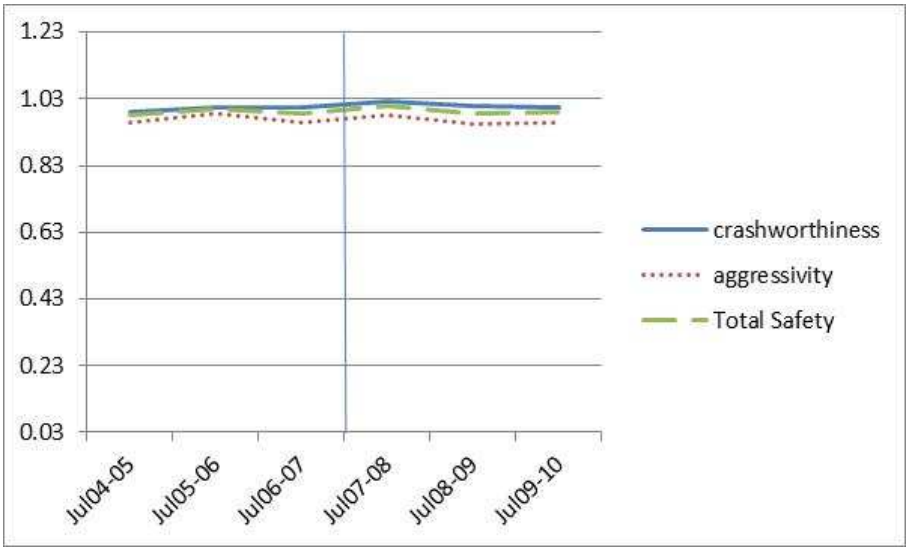


Figure 10 – Relative secondary safety of the Provisional driver crash fleet for drivers aged under 25 relative to the ratings for drivers on their *Learner licences* over the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

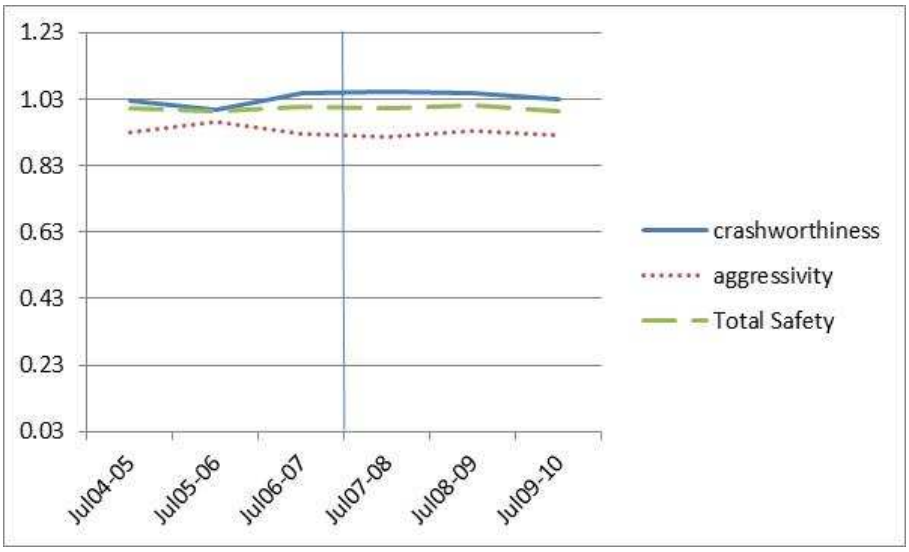


Figure 11 – Relative secondary safety of the Provisional driver crash fleet for drivers aged under 25 relative to the ratings for drivers *aged 25 and over* on their *Provisional licences* over the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

Figure 9, Figure 10 and Figure 11 show no evidence of any trends in the secondary safety ratings for the under-25-year-old Provisional driver crash fleets relative to other fleets that were not directly affected by the regulation.

Figure 12 and Figure 13 show the secondary ratings of all drivers, but just for vehicles identified as high powered (Figure 12) and vehicles not identified as high powered (Figure 13). These show that the high powered vehicles had much higher aggressivity, which was compensated for (in terms of Total Safety) by superior crashworthiness. The Total Safety ratings indicate that both fleets were similar at the start of the period shown, but the high powered vehicles improved faster and were rated as safer at the middle and end of the period.

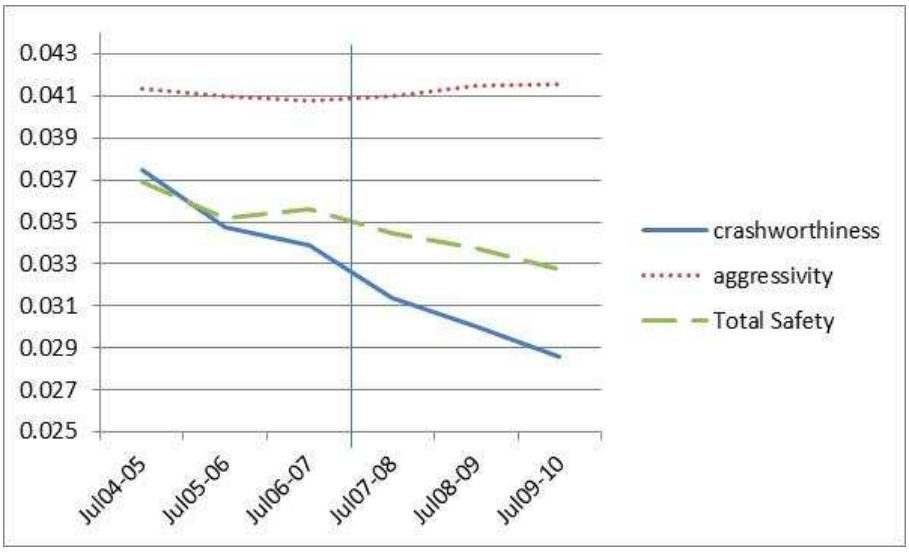


Figure 12 – Secondary safety of all vehicles identified as *high powered* crashed in Queensland by any driver group over the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

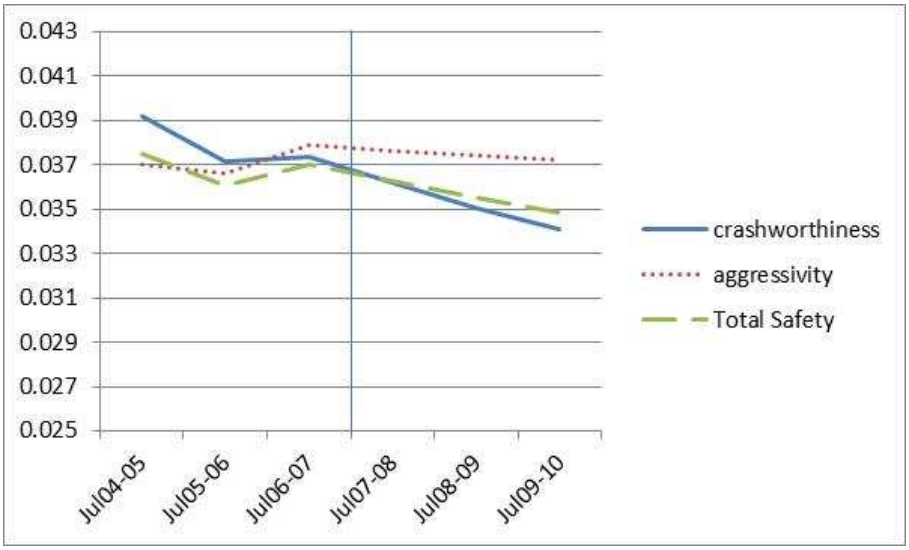


Figure 13 – Secondary safety of all vehicles identified as *not high powered* crashed in Queensland by any driver group over the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

9.2.2 Prevalence of restricted vehicles in on-road fleet post-regulation

In a previous study of the risk associated with high powered vehicles when driven by drivers aged under 25 (Keall and Newstead, 2011), it was estimated that these vehicles were associated with a 69% elevated risk, which means that they are overrepresented in crash data. Table 25 shows the number of crashed vehicles analysed by the period in which the crash occurred for P-plated drivers aged under 25. Note that the proportions of the crash fleet identified as restricted are the same figures that are plotted in Figure 14 by the

dotted line. Using the crash data, together with the estimated relative risk of the restricted vehicles, restricted vehicles as a proportion of the *on-road* fleet driven by P-plated drivers aged under 25 can be estimated. Following the introduction of the regulation, 2.6% of the crash fleet for this licensing group were restricted vehicles. This means that restricted vehicles can be assumed to have constituted about 1.6% of the on-road fleet for this licensing group (see the formula for $\hat{p}$ in the Appendix C).

Table 25- Raw numbers of crash-involved vehicles driven by P-plated drivers aged under 25 during specified periods, including number and percentage classified as restricted as proportion of all vehicles

Period	pre/post regulation	n vehicles	n restricted	%restricted
Jul04-Jun05	pre	5,547	119	2.1%
Jul05-Jun06	pre	5,443	139	2.6%
Jul06-Jun07	pre	5,043	178	3.5%
Jul07-Jun08	post	5,582	131	2.3%
Jul08-Jun09	post	4,351	137	3.1%
Jul09-Dec09	post	1,905	39	2.0%

9.2.3 Changes in prevalence of high powered vehicles associated with vehicle restrictions

Figure 14 shows how high powered vehicles as a proportion of the crash fleet have been changing over the time period studied. To give an accurate picture of change over time, the proportions are for the number of vehicles definitely known to be restricted divided by the total number of vehicles that were able to be classified as either restricted or not restricted. For all groups there was a drop in prevalence from before the regulation was introduced (the vertical line) to after. The following graph (Figure 14) shows the prevalence for the licensing group affected (P-plate drivers aged under 25) divided by the prevalence for other licensing groups. This indicates how the prevalence changed differentially for the targeted group compared to other groups. Compared to the three comparison groups shown the prevalence for P-plate drivers aged under 25 dropped, as might be expected. Learner drivers are not used as a comparison group because of the very small number of crash-involved restricted vehicles studied (only 96 in total, spread over the 6 years).

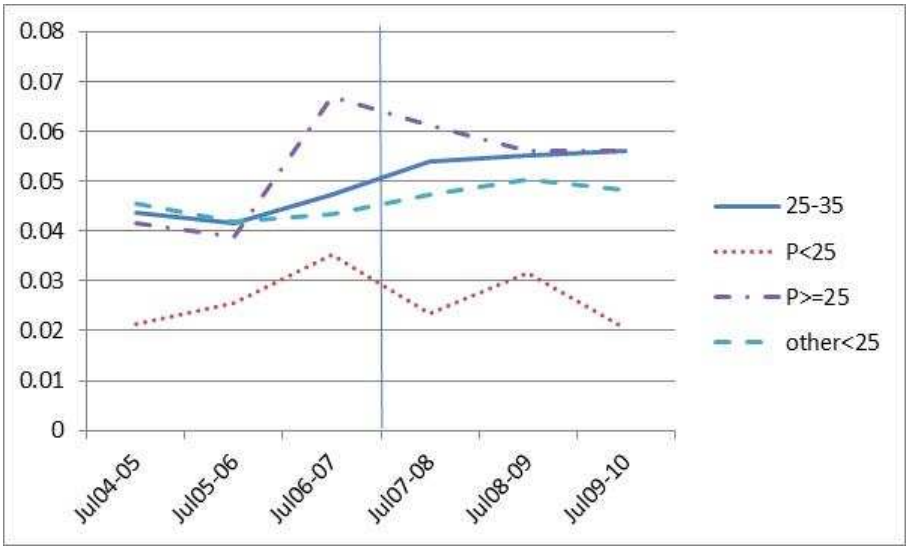


Figure 14 – *Prevalence* of restricted vehicles crashed by Full licensed drivers aged 25-35, driven by P-plate drivers aged under 25, driven by other (non-P-plate and non-Learners) aged under 25 and driven by P-plate drivers aged 25 and over in the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

An estimate of the sizes of these relative prevalence drops was provided by logistic regression analysis, whose results are shown in Table 26. The drop in the average level of the points shown Table 26 are estimated by the column "All vehicles", which is probably the best estimate of relative prevalence if we assume that the decoding procedure did a relatively good job of identifying the high powered vehicles subject to restrictions.

Table 26- Relative drop (with 95% CIs*) in prevalence of restricted vehicles for P-plate drivers aged under 25 compared to the change in prevalence for other specified licensing groups crashed in the three years preceding the introduction of the regulation and the two-and-a-half years following: restricted vehicles as proportion of all vehicles and as proportion just of those able to be classified.

Compared to:		All vehicles	Vehicles able to be classified
Non-L or P	Age <25	16% (-2%, 30%)	21% (4%, 35%)
Non-L or P	Age 25-35	24% (10%, 36%)	15% (-21%, 40%)
P	Age >=25	18% (-16%, 42%)	-2% (-46%, 29%)

*** Confidence Intervals without a minus sign indicate statistically significant reductions**

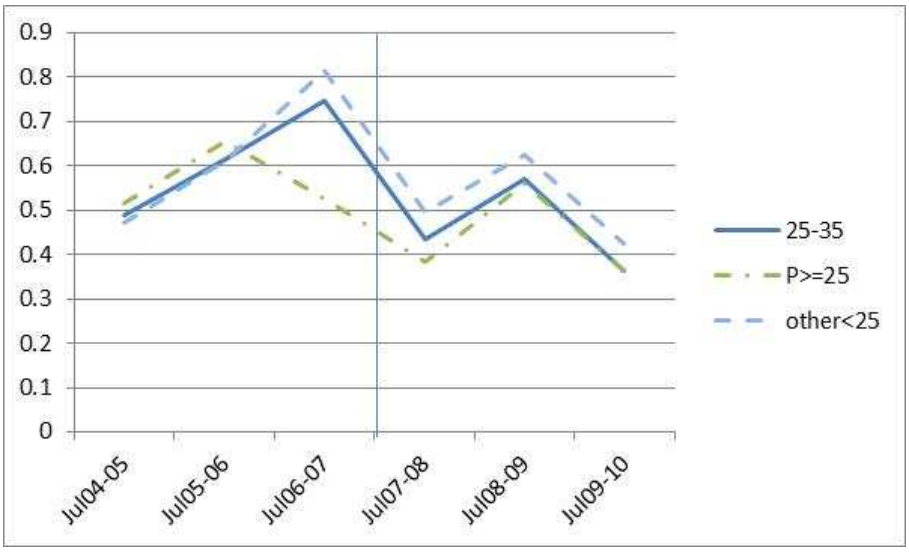


Figure 15 – *Relative prevalence* of restricted vehicles for P-plate drivers aged under 25 compared to the prevalence for other specified licensing groups crashed in the three years preceding the introduction of the regulation (marked by vertical line) and the two-and-a-half years following

The second column of Table 26 provides estimates based just on the crashed vehicles that were definitely able to be classified, and show much more variability. They would provide a good measure if we assume that the decoding procedure did an equally good job of decoding the restricted vehicles as for the other vehicles. To give an example of the interpretation of these figures, the solid line in Figure 15 can be seen as representing an average 24% drop (third row, second column of Table 26) in the relative prevalence of the restricted vehicles for P-plated drivers aged under 25 compared to the prevalence for the mainly fully licensed drivers aged 25-35. This is the estimated size of the drop associated with the introduction of the regulation. Of the six estimates shown in Table 26, the estimate using *all vehicles* and drivers *aged 25-35, non-L or P* with its associated confidence interval may be the best estimate to use in the ensuing computations as this group is a feasible comparison group with sufficient amounts of data to have a relatively narrow confidence interval, which nevertheless spans most of the other estimates presented (10% to 36%).

9.2.4 Changes in crash and injury rates associated with vehicle restrictions

The estimated changes in prevalence as shown in Table 25 can be combined with the estimated relative crash rates of the restricted (high-powered) vehicles compared to other vehicles for drivers aged under 25. The estimation method involves estimating a counterfactual crash rate. This is estimated by assuming that the 24% drop in the proportion of the crash fleet driving by P-plated drivers aged under 25 had not occurred (see third row, second column of Table 26), for example. The formulas for estimating the changes in crash involvement and injury rates are shown in Appendix C. Table 27 shows the estimates based on the 24% estimated drop in the prevalence of the restricted vehicles, with low and high scenarios calculated from the confidence interval bounds of this prevalence estimate. The injury rate drop is calculated on the basis that the average number of injuries per vehicle for P-plated drivers aged under 25 will be similar for restricted vehicles and for the non-restricted vehicles. As drivers in this group who are driving

restricted vehicles may be breaching the regulations already unless they have some form of exemption, they may also be more liable to breach the carriage of passengers regulation as well, meaning that occupancy rates may be higher in the restricted vehicles and the injury rate drop shown in Table 27 may therefore be slightly underestimated.

Table 27- Estimated reductions in crash involvement and injury rates for P-plate drivers aged under 25 estimated to be associated with the regulation restricting high performance vehicles for this group: low prevalence scenario, middle prevalence scenario and high prevalence scenario.

Prevalence scenario	Crash involvement rate	Injury rate
Low (10% drop)	0.12%	0.14%
Middle (24% drop)	0.33%	0.41%
High (36% drop)	0.59%	0.73%

It should be noted that the estimates presented in this section and Appendix C assume that the evidence for the difference in risk related to high powered vehicles is associated solely with the vehicle and are in no way an attribute of driver personality with respect to propensity for risk taking which might also be related to vehicle types choice. If the risk attributable to high powered vehicle use by novice drivers were in part or entirely due to the personality of driver choosing these cars, then the change in crash risk estimated through the high powered vehicle restriction would be an over estimate. This is because all or part of the risk would transfer with the driver to whatever other vehicle type was chosen instead of the high powered vehicle that is restricted. At very least, the results presented here give an upper bound on the crash effects that could be attributed to the high powered vehicle restrictions for novice drivers.

9.3 DISCUSSION

This section of the study has analysed the change in prevalence of the set of vehicles specified as restricted by the recently enacted regulation that is part of the Queensland graduated driver licensing system. The restricted vehicle regulation was introduced in July 2007 and focused on a set of vehicles with high power to weight ratios, capable of rapid acceleration that creates a potential elevated crash and injury risk to young novice drivers, as indicated by recent research (Keall and Newstead, 2011). The current study looked at crash data for the three-year period before the regulation was introduced compared to the two-and-a-half year period subsequent to the regulation. Using a likely comparable licensing group, those aged 25-35 who were not subject to the regulation, it was estimated that restricted vehicles as a proportion of the crash fleet had fallen for the P-plated drivers aged 24 or under by about 24%, with a 95% confidence interval of 10% to 36%. Some drivers would have been granted exemptions to the regulation for example, to drive a vehicle for employment. However, the current analysis could not identify those drivers with such exemptions. Based on this estimated drop in prevalence of the restricted vehicles, combined with existing estimate of the excess risk they pose to young drivers (Keall and Newstead, 2011), it was estimated that the introduction of the vehicle restrictions was associated with a reduction of 0.33% in the crash-involvement rate of the group affected (P-plated drivers aged under 25) and 0.42% in the injury rate (which also includes injuries occurring to other vehicles or pedestrians into which the given vehicle may collide). Although these are modest safety benefits, it is worth noting that the pre-regulation prevalence of the restricted vehicles amongst this licensing group's crash fleet was low, only 2.7%. This means that potential *maximum* safety effect of regulation, with 100% compliance (and taking into account the expected change in the fleets that might have occurred in the absence of regulation), would only have been 1.4% and 2.0% for the crash involvement and injury rates respectively. As noted, these figures can be further considered a maximum since it is not known how much of the additional risk attributable to novice drivers in high powered vehicles is due to the personality types that currently choose to drive high powered vehicles; a component of risk that will potentially not be reduced through vehicle restrictions.

The analysis of the three secondary safety ratings over the period encompassing the introduction of the high powered vehicle restrictions showed little apparent effect on fleet secondary safety associated with the restrictions. This is unsurprising as the high powered vehicles were always a relatively small constituent of the fleet, particularly of younger drivers. The analysis of the secondary safety ratings by whether or not the vehicle was identified as high powered indicates that such vehicles tend to have relatively high aggressivity (more liable to cause serious injury to occupants of other vehicles), but to have overall secondary safety, represented by the Total Safety Index, generally superior to the vehicle fleet not identified as high powered. This was because they were rated as generally providing relatively good protection to the driver (crashworthiness). So although preventing a driver group from using these vehicles would theoretically reduce fleet secondary safety levels, there was no evidence that this was happening.

When estimating the effects of new policy, it is usual to create a counterfactual, which is a situation that would have resulted had the policy not been enacted. In the current study, this is attempted by identifying licensing groups unaffected by the policy who may otherwise be similar to the group being studied (here, P-plated drivers aged under 25). For the crash fleets of comparable licensing groups, the prevalence of the high powered vehicles was generally increasing over the period studied, indicating that prevalence for the P-plated drivers aged under 25 may well have also increased in the absence of regulation.

It is possible that other groups can also be affected by the regulation. The regulation in the long term may reduce the number of high performance vehicles in the fleet generally, although such effects are probably unlikely in the current study since the regulation was relatively new. Alternatively, regulation may generate a "forbidden fruit" demand for the restricted vehicles, where they represent a badge marking progression to full licensure. Such effects could increase the demand for these vehicles for licensing groups unaffected by the regulation. Again, these effects may take longer to develop than the period studied here and are therefore unlikely to have affected the current analysis.

9.4 CONCLUSIONS

This study aimed to estimate the impact of the high powered vehicle restrictions that were introduced as part of the Queensland GLS from 1 July 2007 for drivers aged under 25 with a Provisional licence. The evaluation was in terms of the regulation's estimated effects on crash and injury outcomes. An analysis of this regulation's effect on fleet secondary safety (crashworthiness and aggressivity) showed little change. From crash data categorised according to whether the vehicle was restricted or not, it was estimated that in the two-and-a-half years following the regulation, only about 1.6% of drivers aged under 25 with a Provisional licence were driving restricted vehicles when they crashed. It was also estimated that the regulation was associated with an approximately 24% reduction in restricted vehicles as a proportion of the crash fleet for this licensing group. This, when combined with previously estimated risk for these vehicles and assuming that risk is attributable fully to the vehicle and not the driver characteristics, provided estimates of a 0.3% reduction in crashes and a 0.4% reduction in injuries for drivers aged under 25 with a Provisional licence. As the restricted vehicles are relatively rare in the fleet, even 100% compliance with the regulation would only have yielded reductions of 1.4% and 2.0% for the crash involvement and injury rates respectively.

10 SECONDARY EVALUATION: SELF-REPORTED DRIVER BEHAVIOUR OF P1 DRIVERS

10.1 INTRODUCTION AND METHOD

10.1.1 Background and survey aims

A self-report survey was developed with an initial focus on the attitudes and behaviours of newly licensed P1 drivers regarding the logbook requirement. The scope of the survey was expanded to gain insight into attitudes towards licensing components (e.g. peer passenger restriction) that may influence the effectiveness of the GLS but cannot be measured solely through the crash and infringement databases.

There are two further factors that may influence crash risk that the GLS does not currently address also measured in the survey. They are parental involvement, and the extent to which the young novice drivers' vehicles will protect them in the event of a crash (i.e. secondary safety).

The most significant difference between Learner and P1 driving is the requirement for the presence of a fully licensed supervisor. As shown in Figure 1 and Figure 3, this change corresponds to a major increase in crash risk for novice drivers. It is however, relatively unknown how rapid and complete the transition to unsupervised driving is on gaining a P1 driver licence and hence what contribution this might have to increasing crash risk. It is also unknown how P1 driver crash risk might be mitigated through continued parental involvement in driving supervision. The current prevalence of continued driver supervision in the P1 phase along with attitudes and barriers to this occurring has been considered in the survey.

Analysis of novice driver vehicle choice in Australia has shown new licensed drivers typically crash in older, less safe cars than more experienced drivers (Whelan et al, 2009). It also found that safer vehicle choices could reduce novice driver road trauma between 60 and 80% depending on financial constraints. Given this observation, it is important to understand how a change in the type of vehicle driven between learner and P1 phase contributes to the increase in injury risk observed between these two stages. It is also important to understand the motivations for this change and what potential influences might be able to lead to safer vehicle choices for P drivers. This was also a focus of the survey.

The following research questions guided the development of the survey:

1. What was the P1 driver's experience of the Learner driver phase, and in particular the logbook requirement?
2. What has been the level of parental involvement during the P1 phase so far in comparison to the Learner phase and are there any issues related to the peer passenger restriction?
3. Throughout the Learner and P1 phases, what type of vehicle did novices drive and what was the nature of vehicle ownership?

10.1.2 Methodology

Respondents' anonymous self-reported survey data was merged with their de-identified licensing, crash and infringement history extracted from the TMR databases. In order to undertake this merge TMR extracted the relevant data and contacted P1 drivers on behalf

of MUARC so that no identifiable information was sent to MUARC. TMR requested the names and postal address of 5,000 newly licensed P1 drivers from the licensing database. The P1 drivers' licensing history, infringement, and crash records were also extracted. Further details of the procedures for collecting survey data can be found in Section 8.2.

10.1.2.1 Survey development

The research questions related to three areas; experience on the Learner phase, particularly the logbook, parental involvement in the P1 phase, vehicle choice and ownership factors relating to secondary safety. The three areas and the points that were used to develop the survey in order to address the research questions are provided in Table 28.

Table 28: Development of the survey by research question

Research question area	Specific areas of the survey
Experience during Learner phase	• Ascertain whether the 100 hours was spread over the Learner phase and measure the driving environment (i.e. road type, supervisor, professional instruction) which the Learner gained their 100 hours • Ascertain if there were any issues related to satisfying the logbook requirement
Parental involvement and peer passenger restriction	• Ascertain the level of parental involvement during the first few months of the P1 licence based on: o living at home status, o whether the P1 driver has driven with their supervisor, o whether parents impose any restrictions in addition to the GLS restrictions • Measure issues relating to the peer passenger restriction
Vehicle safety	• Ascertain make/model/vehicle ownership status of main car that was driven during the Learner and P1 phase • Ascertain whether the car driven during Learner phase is different to P1 phase • Ascertain whether P1 drivers who do not own their own vehicle plan to buy a vehicle in the next 2-3 months • Ascertain vehicle choice factors, including role of vehicle safety and level of parental involvement

At the end of the survey respondents were provided space to write additional comments with the question "Do you have any other comments to make regarding your experiences/feedback about the licensing system:" The results of this section of the survey are presented in Section 10.2.5. The aim of the analysis was to establish the nature of participants' comments, and assess the proportion of all respondents providing comments.

10.1.2.2 Procedure

P1 drivers were sent a 2-page introductory letter attached to the survey. To maintain privacy the letter was sent by TMR on behalf of the project manager at MUARC. Each survey was allocated a randomly generated key that linked the survey back to personal identifiers held by TMR. MUARC did not have access to this linking table, only the

random key. The letter invited P1 drivers to complete and return to MUARC a survey asking them about their attitudes towards the new licensing system. The survey was estimated to take 15-minutes to complete. The letter advised P1 drivers that the survey could be completed and returned either online or via paper using a reply-paid envelope provided, that their responses would be linked to their de-identified driving history for research purposes only, and that their individual responses would only be viewed by MUARC not TMR and would therefore remain anonymous. From the date that the survey was mailed out, invited P1 drivers had just over 5 weeks to complete and return the survey in order to be included in the draw for one of 10 cash prizes each to the value of $100. De-identified crash and infringement data for the 5000 P1 drivers were provided to MUARC by TMR and linked via the randomly generated key. Incentives for completing the survey were also distributed by TMR based on the randomly generated key values if the survey respondents. Some of the many benefits of linking the survey data with the TMR data were the ability to calculate non-response bias in terms of crash- and traffic infringement-involvement, and to use the self-report data to predict factors contributing to crash involvement. The study was approved by the Monash University Human Research Ethics Committee.

10.1.2.3 Sample population

Five thousand Queensland P1 drivers who had held their licence for a minimum of 3-months and a maximum of 6-months were randomly selected by TMR from the TMR licensing database. Males comprised 53% of the sample (2,344 female P1 drivers, 2,656 male P1 drivers). There was a total of 302 traffic infringements observed in the invited sample. As the minimum entry age for P1 is 17-years, and the maximum P1 entry age (i.e. the age before the entire P1 phase is skipped) is 25 years, the data extraction only included P1 drivers who were aged between 17 – 25 years. As of June 1 2010, the total number of eligible P1 licence holders was 14,459 for the period December 1 2009 - March 31 2010. The sample population comprised 34.5% of the total eligible population.

10.2 RESULTS

10.2.1 Final sample demographics

The final sample (N=1,404) represented a response rate of 28%. There were 301 surveys completed online and submitted electronically, and 1,103 surveys completed via pen and paper and returned via mail using the reply-paid envelope. Table 29 displays the proportion of completed surveys by gender and survey completion method.

Table 29: Final sample size by gender and survey method

	Completed online	**Completed pen and paper**	**Total**
Male	158 (11.25%)	418 (29.7%)	576 (41.0%)
Female	136 (9.6%)	660 (47.0%)	796 (56.7%)
Gender N/A*	7 (0.5%)	25 (1.8%)	32 (2.3%)
Total	301 (21.4%)	1103 (78.5%)	1404 (100%)

* Denotes gender was not specified, i.e. missing data.

The majority of the survey respondents were aged either 17 or 18 years (50%), with 19 year-olds comprising 13% of the sample. Of the invited sample, non-respondents accounted for 88% of the total proportion of traffic infringements. Respondents' current occupational and educational activities are displayed in Table 30.

Table 30: Occupational /educational activity

Occupational or educational activity	Frequency (%) (multiple responses allowed)
Enrolled at high school/secondary school	375 (19.54%)
Enrolled at University	446 (23.24%)
Enrolled at TAFE	119 (6.20%)
Employed as an apprentice	119 (5.99%)
Employed part-time	502 (26.16%)
Employed full-time	224 (11.67%)
Unemployed/Seeking employment	101 (5.26%)
Home duties (not working or studying)	37 (1.93%)
Benefit receipts	0 (0.00%)
Total	1,919 (100%)

Cross-tabulation of responses to the educational and occupational activity question indicated that respondents who reported being *enrolled at University* were slightly more likely to report also being *employed part-time* (41%) compared to respondents *enrolled at high-school/secondary school* (31%). The majority of respondents reported living with their *mother and father* (62%) and the next most common response option for living status (which was low compared with *mother and father*) was with their *mother only* (8%), followed by *mother and stepfather* (6%). By combining the response options involving at least one parent the results showed that 82% of respondents reported living with at least one parent. There was a balanced number of responses to the question "were you the first child in your family to be on P-plates?" with 55 per cent of respondents reporting *yes*. Sixty-three per cent of respondents reported *no* to the question "while you were on your Ls, was there anyone else in your household who were on their Ls or Ps?"

The following table compares survey respondents with non-respondents on the type and frequency of infringements. The table indicates that there was a non-response bias in that the non-respondent group accounted for 88.1% of the total proportion of infringements in comparison to respondents who accounted for only 11.9%. The most common infringement type for both samples was good driving behaviour followed by demerit point suspension.

Table 31: Comparison of infringement type by survey respondents and non-respondents

Infringement Type	Respondents	Non-response	Total
Disqualification	3 (1%)	40 (13.2%)	43 (14.2%)
Demerit Point Suspension	12 (4%)	82 (27.2%)	94 (31.1%)
Good Driving Behaviour Option	20 (6.6%)	90 (29.8%)	110 (36.4%)
High Speed Suspension	0 (0%)	7 (2.3%)	7 (2.3%)
Immediate Suspension with Licence	0 (0%)	3 (1%)	3 (1%)
State Penalties Enforcement Registry (SPER) Suspension	1 (0.3%)	43 (14.2%)	44 (14.6%)
Special Hardship Order Restricted	0 (0%)	1 (0.3%)	1 (0.3%)
Total	36 (11.9%)	266 (88.1%)	302 (100%)

The number of Police-reported crashes by survey response status was calculated and a similar finding to the infringement data was revealed: there were 11 Police-reported crashes for the survey respondent group and 62 Police-reported crashes for the non-respondent group. Therefore of the 73 Police-reported crashes identified for the invited survey sample (n=5,000) 85% of crashes involved drivers who did not respond to the survey with the remaining 15% of crashes involving drivers who responded to the survey.

10.2.2 Learner driver phase

Almost all respondents (94%) reported that they had professional lessons whilst learning to drive. Of the respondents reporting that they had professional lessons, the number of lessons ranged from 1 to 90, with 60% reported that they had between 1-7 lessons and 90% reporting that they had between 1-14 lessons. Exploratory analysis explored differences in the number of lessons based on the response to the question "were you the first child in your family to be on P-plates". The results indicated that there was no difference in the number of lessons based on whether respondents were the first child in the family to be on P-plates. The duration of lessons was most likely to be *up to one hour* (82%) compared with *more than one hour* (13%). The estimates for the number of kilometres that each professional lesson covered tended to be in the range of *10–30km* (64.5%), in comparison to *less than 10km (10%),* and *30km or more* (21%). The proportion of responses, in order of frequency, to the question "*at what stage of your Ls did you have professional lessons* are as follows: *the end (32%), the middle and end (21%), all the way through (18%), the beginning and end (18%), the beginning (2%), the beginning and middle (2%), the middle (2%).* The reason(s) for taking professional lessons are provided in Table 32, respondents were asked to select as many options that applied.

Table 32: Responses to the question "What were your reasons for having professional lessons (please select as many boxes that apply)?"

	Frequency (%) (multiple responses allowed)
To decrease the total number of hours required for my logbook	53%
Because I wanted to get a mix of professional and private lessons	40%
Because other supervision was not available	4%
They were paid for me	16%
For the extra safety provided by dual control cars	7%
To learn how to operate the vehicle (core driving skills) before building driving experience	24%
Parents/guardians did not feel comfortable teaching me	7%
Thought professional trainer would teach better driving practices	42%
To check my driving skills were good enough to pass the driving test	63%
I did not have access to a vehicle to learn to drive in	2%
My parents only have an automatic car(s) and I wanted to learn in a manual car	13%
My parents only have a manual car(s) and I wanted to learn in an automatic car	0.4

Respondents were asked to list the relationship with all of their supervisors and then nominate the main supervisor. The responses to these two questions are compared in Table 33.

Table 33: Responses to the questions "Who supervised your driving when you had your Ls (please select as many boxes that apply)?", and, "Who was your MAIN supervisor (please select ONE box only)?"

	Proportion of total sample all supervisors (multiple responses allowed)	Proportion of total sample *main* supervisor
Mother/female guardian	89%	54%
Father/male guardian	84%	34%
Sister	9%	0.3%
Brother	9%	0.2%
Partner/spouse	3%	0.8%
Aunt	5%	0.2%
Uncle	6%	0.4%
Female cousin	1%	0%
Male cousin	1%	0%
Grandmother/nana	8%	0.4%
Grandfather/granddad	8%	0.5%
Female friend	6%	0.4%
Male friend	10%	1%
Professional driving instructor	65%	3%

The proportion of responses, in order of frequency, to the question "*at what stage of your Ls did you have professional lessons* are as follows: *all the way through (58%), the middle and end (13%), the beginning and middle (12%), the middle (8%), the beginning (4%), the end (4%), the beginning and end (2%), only received professional instruction* (0.2%).

The trip distance for non-professional supervision was more likely to be 10-30km (51%), in comparison with less than 10km (12%) and 30km or more (36%). Trip duration was either: *30 minutes to one hour* (48%), *up to 30 minutes* (24%), or *one hour of more* (24%). The most common responses for the frequency of trips with the non-professional supervisor was *more than once a week but less than once a day* (42%), *more than once a day (21%), and once a day (20%).*

Table 34: Proportion of driving experience gained in various driving situation

Driving situation:	Never	Once	2-10 times	More than 10 times
During weather conditions that made it difficult to see, e.g. sunrise, sunset, fog	1%	4%	57%	37%
On wet roads	0.6%	2.4%	49%	48%
On gravel/unsealed roads	8%	13%	50%	29%
In heavy city traffic	6%	9%	43%	40%
In a 100 km/h area during daylight hours	0.4%	3%	26%	71%
In a 100 km/h area when it was dark	4%	6%	35%	55%
In a 50 km/h area during daylight hours	0%	0.5%	11%	88%
In a 50 km/h area when it was dark	0.8%	2%	18%	79%
On any long trips (greater than 100 km in distance)	12%	14%	50%	24%
With passengers other than supervisor	5%	4%	29%	61%
In metropolitan Brisbane	34%	13%	28%	25%
In a country town	16%	11%	35%	38%
On and open country road	17%	13%	36%	34%

Just for driving experience / no particular purpose – my supervisor decided	10%	8%	42%	40%
Just for driving experience / no particular purpose – I decided	10%	7%	41%	42%
To and from school / tertiary institutions / work	8%	3%	20%	70%
To / from sporting or recreational activities	14%	7%	30%	50%
To / from shops	1%	1%	23%	74%
On holiday trips	27%	14%	45%	14%
As a sober driver (for example, as a designated driver)	69%	9%	13%	8%

The following tables outline respondents' attitudes towards the key GLS initiatives introduced from 1 July 2007; the logbook requirement and the peer passenger restriction.

Table 35: Responses to the question "The following statements are about how you feel about the requirement to gain 100 hours of driving experience and to record this in a logbook"

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The logbook was difficult to maintain	6.8%	26.5%	18.5%	31.6%	16.2%
I would often forget to fill out my logbook	10.4%	26.3%	10.2%	34.9%	18.1%
My supervisor often had to remind me to fill out my logbook	16.7%	30.3%	14.9%	26.3%	11.5%
The logbook was a burden to maintain	6.8%	19.2%	14.1%	31.6%	28.1%
Gaining 100 hours of driving was easy	19.5%	28.6%	19.4%	19%	13%
Often, someone else had to encourage me to go out driving	32.6%	32.5%	15.2%	15%	4.3%
The logbook was a source of many arguments with my supervisor	33.2%	35.7%	14%	10.9%	6%
I think I would have driven 100 hours or more during my Ls, even if I didn't keep a log	7.9%	22.5%	17.7%	27.8%	23.9%
I think gaining 100 hours made me a safer driver	5.7%	11%	21.1%	35.6%	26.3%
I gained well in excess of the 100 hours required (i.e. above 120 hours)	7.1%	20.1%	16.3%	28%	28.2%

The majority of respondents reported filling out their logbook entry each time they drove (64%), with only 3% indicating that they filled the logbook out at the end of the Learner licence period. The majority knew someone that had falsified their logbook (87%). Respondents were asked whether they were tempted to falsify their logbook hours with three response options: *yes, but I didn't* (38%), *yes, occasionally I did* (33%), and *no* (28%). The next question asked "if you did add hours to your logbook how many hours were falsified", with three response options: less than 10 hours (34%), more than 10 hours but less than 30 hours (6%), more than 30 hours (3%), with 57% of respondents not responding to this question. There was a technical error in the online survey whereby the responses to the falsification of logbook questions were invalid, hence the reported responses are restricted to mail returned surveys (n=1,303). Respondents were asked how often they drove unsupervised on public roads, and they were reminded that their responses were anonymous. The majority of respondents indicated that they had never driven unsupervised on public roads (77%). Results showed that 10% of respondents had driven unsupervised between 2-10

times, 9% had driven unsupervised once, and 4% had driven unsupervised more than 10 times.

P1 driving exposure was measured by asking respondents "Now that you are on your Ps, on average how often do you drive?". The majority of respondents indicated that they were most likely to drive *more than once a day* (68%) with the next most common response being *more than once a week but less than once a day* (15%), followed by *once a day* (12%), *once a week* (2.5%), *monthly (1%), less than monthly (1%), and once every fortnight (1%).* Respondents indicated that they were most likely to travel between *50-200km per week (53%),* compared with *200+km per week (25%),* and *less than 50km per week (22%).*

Based on concerns that drivers were not undertaking the P1 exit test (hazard perception test) to obtain their P2 licence a question was included in the survey that asked "*how likely are you to complete the Hazard Perception Test as soon as you are eligible?"*. The majority of respondents (86% in total) indicated that they were either *very likely* (63%) or *likely* (23%) to complete the Hazard Perception Test as soon as they were eligible.

10.2.3 Parental involvement during P1 period and peer passenger restriction

Eighty-two per cent of respondents reported living with at least one parent. Responses to parental involvement during the P1 phase questions are shown in Table 36 and Table 37 below.

Table 36: Responses to the question "Since being on your Ps have you driven a car with a fully licensed driver as a passenger?"

	Frequency (%)
Yes often as we travel together regularly	1%
Yes occasionally we will go out specifically to practice my driving	23%
Yes occasionally if we are going somewhere together	3%
No since being on my Ps I haven't travelled with a fully licensed driver	72%

Table 37: Responses to the question "The following statements are about whether your parent(s)/guardian place any limitations on your driving (if you don't live with a parent/guardian please go to question 28a)"

	Frequency (% of total final sample)
I have to be home by a certain time	17%
I have to tell them where I am going	57%
I cannot drive without their permission	9%
I am not allowed to drive in bad weather	2%
I am not allowed to drive at night	0.6%
I have to tell them who I am going with	25%
I am not allowed to drive on high speed roads	0.5%
They limit my passengers	8%
I am not allowed to have my mobile phone turned on when driving	9%

Table 38 displays the proportion of responses to the Likert scale questions measuring attitudes towards the peer passenger restriction.

Table 38: Respondents attitudes towards the peer passenger restriction

Question:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I have no problem complying with the peer passenger restriction	10%	15.7%	21.2%	30.8%	22.1%
I won't ride with anyone who, by law, shouldn't carry peer passengers in their car	8%	19.4%	25.6%	28%	18.7%
If I ever breached the peer passenger restriction I would always worry that my parents might catch me	17.9%	29%	21.9%	20.4%	10.6%
If I ever breached the peer passenger restriction I would always worry that the police might catch me	3.7%	7.5%	12.9%	42.5%	33%
My friends often encourage me to ignore the peer passenger restriction	31.7%	37.1%	17.5%	9.8%	3.6%
I have unintentionally breached the peer passenger restriction when my journey has gone past 11pm	27.4%	28%	11%	22.9%	10.3%
I have access to a car whenever I want	3.2%	7.6%	7.5%	29.3%	52.1%
I often carry peer passengers legally (i.e. during the day	5.1%	5.9%	9.1%	35.8%	43.7%

Respondents' self-reported breach of the peer passenger restriction is presented in Figure 16: Proportion of respondents being tempted to breach the peer passenger restriction

. The wording of the question was "since getting your P1 license, have you ever been tempted to carry more than one passenger under the age of 21 years between 11pm and 5am without an exemption? *Please be reminded that this information will be kept confidential, and you responses are anonymous".*

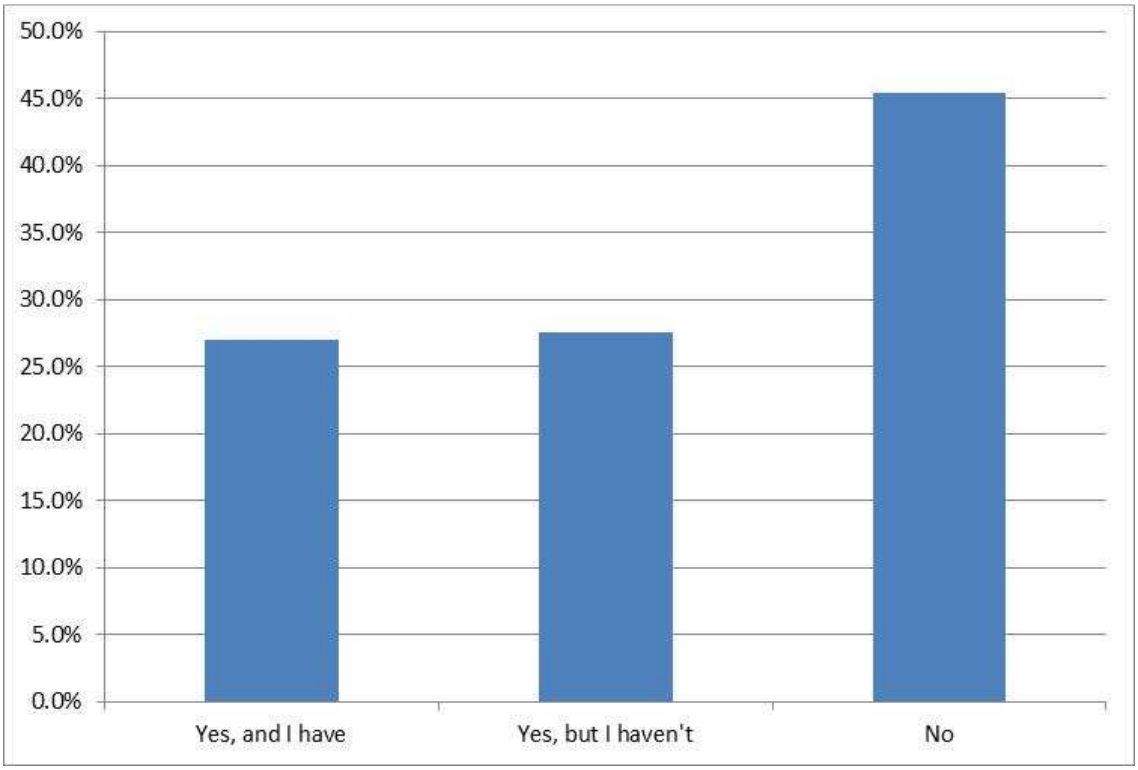


Figure 16: Proportion of respondents being tempted to breach the peer passenger restriction

10.2.4 Vehicle ownership

The majority indicated that they did not know or had not used the Used Car Safety Ratings (82%), with similar responses to the Australian New Car Assessment Program (ANCAP) ratings (84%). Respondents' responses to the questions on ownership of the car they predominantly used as a learner and P1 driver are presented in **Figure *17***.

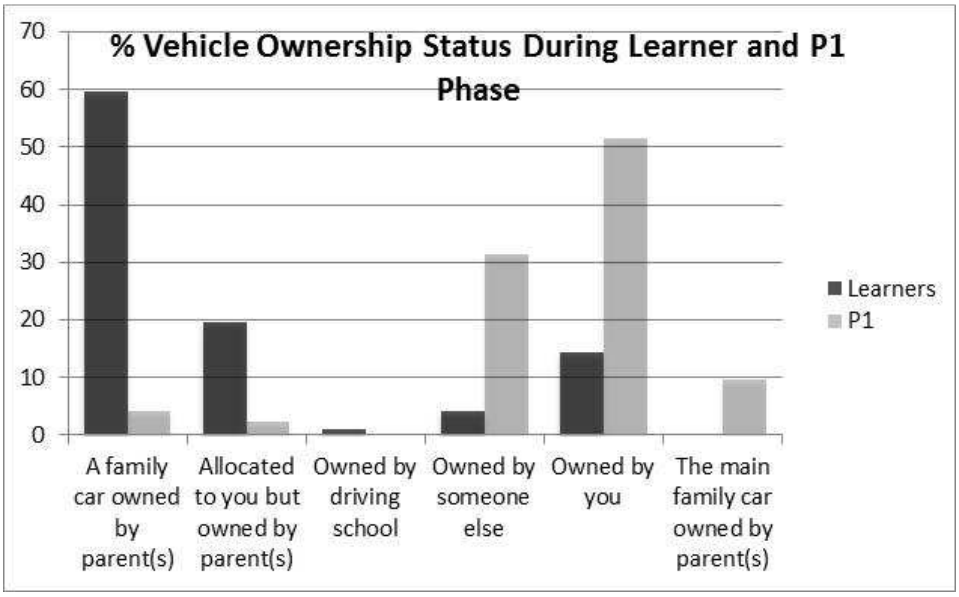


Figure 17: Vehicle ownership status during Learner and P1 phase

There was a clear shift from the number of respondents reportedly driving the family car in the Learner phase to driving a car that they own in the P1 phase. Exploratory analysis confirmed that this trend was consistent across gender and driver age.

Table 39 shows the pattern of vehicle ownership for the Ls and P1 stages of licensure. The most common pattern was for young novice drivers to learn to drive in the family car owned by their parent(s) and then own a vehicle on their P1 phase. The next most common pattern was to learn to drive in the family car owned by their parent(s) but on the P1 phase drive a vehicle that is owned by their parents but allocated to the P1 driver.

Table 39: Vehicle ownership status by licence period

Learners	P1							
		Missing	**Family car owned by parent(s)**	**Allocated to you***	**Owned by someone else**	**Owned by you**	**The main family car owned by your parent(s)**	**Total**
	Missing	0 (0%)	1 (0.1%)	1 (0.1%)	0 (0%)	6 (0.4%)	0 (0%)	8 (0.6%)
	Family car owned by parent(s)	4 (0.3%)	57 (4.1%)	227 (16.2%)	19 (1.4%)	407 (29%)	125 (8.9%)	839 (59.8%)
	Allocated to you*	1 (0.1%)	2 (0.1%)	205 (14.6%)	1 (0.1%)	65 (4.6%)	4 (0.3%)	278 (19.8%)
	Owned by driving school	0 (0%)	1 (0.1%)	2 (0.1%)	4 (0.3%)	8 (0.6%)	1 (0.1%)	16 (1.1%)
	Owned by someone else	1 (0.1%)	0 (0%)	5 (0.4%)	8 (0.6%)	41 (2.9%)	4 (0.3%)	59 (4.2%)
	Owned by you	0 (0%)	0 (0%)	3 (0.2%)	2 (0.1%)	197 (14%)	2 (0.1%)	204 (14.5%)
	Total	6 (0.4%)	61 (4.3%)	443 (31.6%)	34 (2.4%)	724 (51.6%)	136 (9.7%)	1,404 (100%)

*A family car allocated to you but owned by your parent(s)

The majority of respondents reported *no* (86.3%) to the question "are you or your parent(s)/guardian planning to buy a vehicle in the next few months for you to drive – either because you don't own your own vehicle or are planning to upgrade your current vehicle?". Seventy per cent of respondents expect to pay or actually paid between $0-10,000 for their vehicle. Specifically, 40% expect to pay between $0-5,000, and 30% expect to pay between $5,000-10,000. Nineteen per cent expect to pay between $10,000-20,000 and 6% expect to pay $20,000+. The responses to the question "how did you pay for, or expect to pay for your vehicle (please select ONE box only)" are shown in Figure 18.

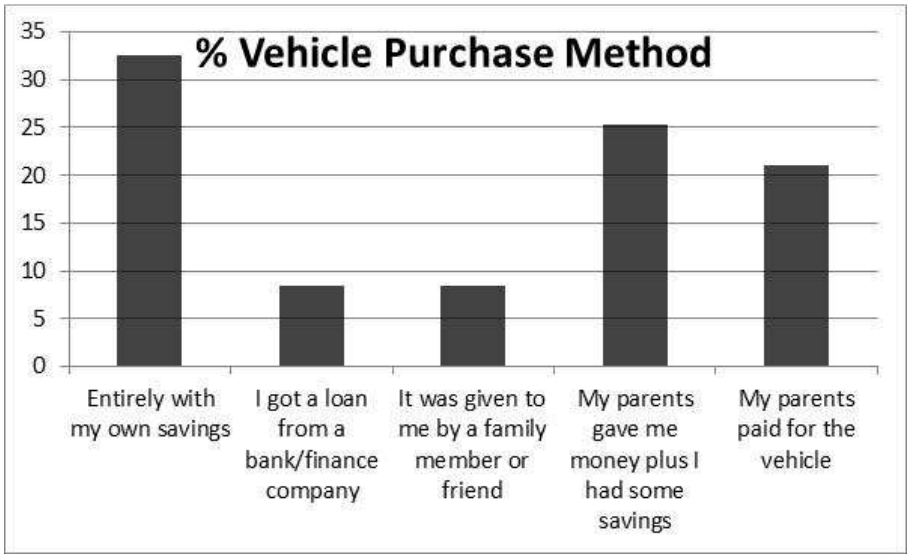


Figure 18: Method of vehicle purchase

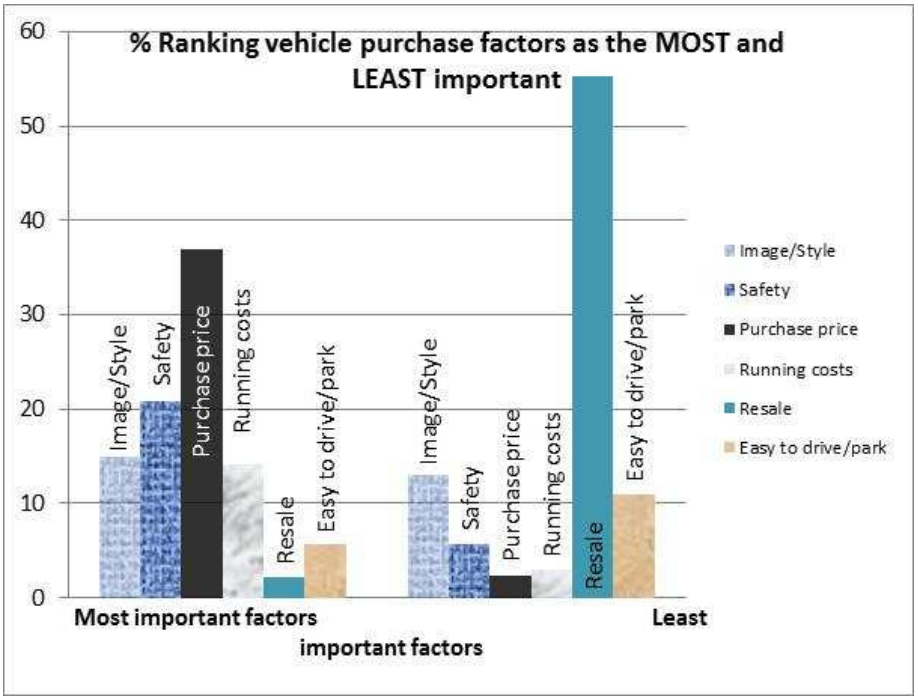


Figure 19: Ranking of the most and least factors influencing vehicle purchase factors

Figure 19 shows that *purchase price* followed by *safety* were the two most important factors reported for respondents' vehicle purchase and *resale* value and *image/style* are regarded the least important factors. The majority of respondents reported *no* (77%) to the question "have you modified, or do you plan to modify, the vehicle you are currently driving in any way?". Exploratory analysis indicated that there were no gender differences for this question.

10.2.5 Open-ended comments on licensing system

There were 591 respondents (or 42% of final sample) providing comments at the end of the survey. This was more than expected. Respondents who completed the survey via mail (80%) were more likely to provide a comment than respondents who completed the survey online (20%). Male respondents (39%) were less likely to provide a comment than female respondents (54%).

Participants' comments were coded into ten broad categories relating to the components of the licensing system. The categories were classified as comments relating to the *logbook, peer passenger restriction, alcohol limit, testing procedure for P1 licence, content of the testing procedure, high-powered vehicle restriction, general comments regarding the licensing system, comments relating to the questionnaire,* and *miscellaneous comments.* Each of the 591 comments were coded and classified across the ten categories. As some of these comments were in-depth they often related to more than one category. The classification of the 591 across the ten categories resulted in a total of 671 comments. The table below provides a summary of the frequency and proportion of comments for each category.

Table 40: Proportion of comments by comment category

Category	Frequency (% of total comments)
Logbook	265 (40%)
Peer passenger restriction	129 (19%)
Alcohol limit	7 (1%)
Testing procedure for P1 licence	23 (3%)
Content of the P1 testing procedure	72 (11%)
High-powered vehicle restriction	28 (4%)
General comments regarding the licensing system	83 (12%)
Comments relating to the questionnaire	18 (2%)
Miscellaneous comments	146 (8%)
Total	671 (100%)

Respondents were more likely to comment on the logbook requirement than any other component of the licensing system. Furthermore, the comments were more likely to be negative (64%) than positive (36%). Twenty one per cent of these comments cited the high rate of logbook falsification, and forty two per cent described the logbook as a burden. Several examples are provided below:

- "*The requirement to log 100 hours of driving helps make drivers more experienced. However the logbooks need to be checked better as I know several people whose log books contained hours not possible to have achieved.",*

- *"I think the logbook has made my driving safer as I complied to the 100hrs however I think with the new rules of 200hrs is too much and unreasonable. I do find the peer passenger restriction difficult to comply with.",*
- *"I think that 100 recorded hours of driving experience is more than enough to qualify an individual to attempt to gain their P-1 license.",*
- *"Log books are a waste of time just made the experience a whole lot more frustrating and tedious", I believe that doing 100 hours is really hard to complete I also believe that a lot of other learners or now P platers would agree with. I believe dropping the hours to around 70 or 80 hours would be a lot better and easier to achieve as after about that time of 80 hours you are fully confident and are ready to be by yourself."*
- *"I believe the 100 hours are great as many of my mates are much better drivers now for it. If not as much pressure was placed on parents to get these hours completed it would be perfect"*

The licensing component with the second-highest number of comments was the peer passenger restriction. Almost all comments relating to the peer passenger restriction (94%) were negative, and this negativity was centred on the restriction preventing lifts home for their friends. Providing a safe mode of transport for friends was a very common comment, for example:

- *"I believe the restriction to one peer passenger between 11pm-5am is stupid because what if my mates need a lift home and its after 11pm it forces them to walk home which can be unsafe at that time of night",*
- *"I think we should be able to pick our mates up from town if they have been drinking and were sober saves them money for a taxi and we know that they get home safe"*

In many cases the issue of not being able to be the designated driver was raised. For example one respondent commented:

- *"For safe drivers the peer curfew is nothing short of a burden. I have spent whole nights not drinking for the purpose of driving only not to be able to drive my (intoxicated or sober) friends home and in some cases having to do laps in order to get stranded people home safely. I believe the curfew encourages drink driving as it eliminates the ability to have a designated driver to look after many people this could mean multiple drunk drivers on the road at any given time where a single designated driver could have discouraged youth from taking the risk.....the peer passenger curfew has been the source of many incidents of frustration knowing that if the curfew was not in place I would be able to help many of my friends find their way home safely".*

The low number of comments relating to the alcohol limit suggests that the zero BAC limit is accepted by majority of young novice drivers.

The low number of comments relating to the procedure for the P1 licence indicates that the test is accepted by majority of young novice drivers. The comments were often negative and related to the logistics of completing the test (including the test time being cancelled by TMR which caused the driver inconvenience), eligibility to sit the test in relation to the achievement of the 100 hours ("*you should be able to sit your licence as soon as you have 100 hours")* and perceived changes to the test ("*I believe that the test to get your Ps should remain the same and not get easier!").*

Almost all comments regarding the content of the P1 test procedure (97%) were related to including some form of mandatory professional driver training in the licensing system. The type of training was either defensive driver training for Learner or P1 drivers, advanced driver training for Learner or P1 drivers, or driving lessons with a professional driving instructor for Learner drivers. Most respondents also suggested that due to costs associated with undertaking driver training courses and taking lessons with a professional driving instructor, the government should include a subsidy - with responses ranging from a part or full subsidy. Some example comments are provided below:

- *"I think all Learner's/ P1 drivers should do a Defensive Driving Course as I found mine extremely helpful in not only teaching me how to drive in difficult conditions- but educating me to avoid difficult situations"*
- "*I believe that supervised driving with a qualified driving instructor is more beneficial than the 100 hr. min requirement. This gives L's drivers an opportunity to learn the correct skills not just the bad habits of their parents".*
- "*Needs to be a greater focus on driver safety courses such as ski pans. i.e. knowing how to control the car in number of scenarios rather than the 100 hrs of driving and the test to get our P's".*
- *"…for professional driving lessons I think there should be some form of subsidy or voucher to allow everyone to be able to access at least one professional driving lesson because I think they are an essential part of learning to drive in assessing the bad habits you may have picked up from your parents and correcting any prevalent mistakes as well as educating the learner to the process of the driving test."*

The majority of comments on the high-powered vehicle restriction were negative (82%). Respondents were generally of the opinion that the high-powered vehicle restriction is unnecessary and argued that as the restriction does not apply to Learner drivers P1 drivers should not be subject to the restriction either.

In comparison to other categories there was a relatively even proportion of positive (44%) and negative (56%) comments in the category *general comments relating to the licensing system*. Of the 83 comments in this category the comments were quite varied. Some respondents believed that the licensing system could be improved by increasing penalties for infringements, others indicated that the licensing system was "*way too strict*", and other respondents indicated that no changes were necessary because the licensing system was "*fair and easy to follow"*.

The comments relating to the questionnaire revealed that four respondents were in the transitional Learner group and were only required to obtain 60 hours of supervised driving experience. One respondent provided a suggestion for questionnaire improvement which will be considered in future survey waves: "The question "*When purchasing your vehicle what factors will be or were a priority*?" Is missing performance as an option." All other comments were either negative (e.g. indicating that the survey was boring), neutral or positive (e.g. "thanks").

Of the 146 miscellaneous comments, the majority of these (69%) were categorised as "random" as they contained smiley faces, irrelevant/neutral comments, for example "no thanks" and "no comment".

10.3 DISCUSSION

The survey questions were aimed at establishing the experience gained during the Learner licence period, the level of parental involvement on the P1 period relative to the Learner licence period, and the vehicle ownership status and type of vehicle driven during the Ls and P1 phase. The response rate was 28% (and this was higher than the estimated response rate of 15%) with the sample comprising slightly more females than males. The demographic questions in the survey indicated that the majority of respondents lived at home with at least one of their parents, were enrolled either in high-school or University, and had undertaken professional lessons whilst on their Learner licence.

A potential response bias was identified in that the majority of respondents had not received traffic infringements or been involved in a Police-reported crash (whereby 88% of the infringements and 85% of Police-reported crashes were accounted for by those not responding to the survey). This suggests that survey respondents are more safety-conscious than non-respondents and this therefore limits the extent to which the findings can be generalised to the wider population of P1 drivers in Queensland. The results to the three research questions are presented below with sub-headings based on the information in Table 28.

10.3.1 Experience on Learner phase

10.3.1.1 Ascertain whether the 100 hours was spread over the Learner phase and measure the Learner's driving environment

Respondents were more likely to receive non-professional supervision all the way through the Learner licence period whereas they were more likely to receive professional supervision at the end the of the Learner licence period only. Both professionally supervised and non-professionally supervised trips generally covered a distance of 10kms or more, and took between 30 minutes to an hour. Almost all respondents received between 1-14 professional lessons on their Ls - this indicates that the incentive for Learner drivers to reduce the required number of hours driving experience by undertaking professional lessons is effective, however the result should be interpreted with caution given the response bias identified in that respondents are considered more safety-conscious than non-respondents. Respondents were more likely to undertake professional lessons towards the middle and end of the Learner period. Most respondents took professional lessons to check that their driving skills were adequate for undertaking the P1 practical driving test, and to decrease the required number of hours of driving experience. It was very uncommon for respondents to indicate that they took professional lessons as they did not have access to a vehicle, or, because other supervision was unavailable.

Most respondents either received supervision from a male or female guardian and to a lesser extent a professional driving instructor. Respondents did not generally receive supervision from other family members (i.e. siblings, grandparents, aunts/uncle, cousins, partner/spouse), or friends. Their main supervisor was most likely to be a female guardian.

The driving environment whereby 100 hours of supervised driving experience was accumulated was generally varied, covering roads with 50 km/h to 100 km/h speed zones, across hour of daylight and night time, on long trips, during inclement weather, in rural areas, and with other passengers in the vehicle other than the supervisor. The driving environment where it appears that respondents lacked experience was driving in metropolitan Brisbane. Almost half of the respondents had never driven (or had only driven once) in metropolitan

Brisbane on their Ls. Prior to the introduction of the logbook requirement it was suggested that Queensland learners were less likely to deliberately practice their driving in a range of situations, including driving in metropolitan areas (Bates et al., 2009). It appears that the logbook mandate may have improved the range of driving situations that learner drivers practice in, with the exception of driving in metropolitan areas.

10.3.1.2 Issues related to satisfying the logbook requirement

In terms of identifying issues relating to the 100 hour driving requirement the majority of respondents agreed or strongly agreed with the following statements: *the logbook was difficult to maintain, I would often forget to fill out my logbook, the logbook was a burden to maintain.* They also tended to disagree or strongly disagree with the statement *gaining 100 hours of driving was easy*. This is in contrast to the findings of Bates et al. (2009) who concluded from their study comparing the experiences of Learner drivers in NSW and Queensland that "mandating a set number of hours of supervised practice for learner drivers does not appear to influence their perceptions of how difficult it is to find time to practice" (Bates et al., 2009, p 57). However they point out that their findings relate to mandating 50 hours of supervised driving and that Learner's perceptions of difficulty in obtaining hours may change if a greater number of hours was mandated.

Conversely the majority of respondents agreed or strongly agreed that they gained above 120 hours, that they would have gained 100 hours even if this was not a requirement, and that by gaining 100 hours of driving they felt that they were a safer driver. Respondents tended to disagree with the statement *often, someone else had to encourage me to go out driving*, and, *the logbook was source of many arguments with my supervisor*. This suggests that while respondents found the logbook to be a burden and obtaining the 100 hours was generally considered a difficult task, they also reported that they would have gained 100 hours even if the logbook mandate did not exist and that they felt that they were a safer driver. Issues relating to the logbook were the most common in the open-ended comments section at the end of the survey. Consistent with the results reported above, many of the respondents' comments indicated that the logbook was a burden and falsification was common.

10.3.2 Parental involvement and peer passenger restriction

10.3.2.1 Ascertain level of parental involvement during the first few months of the P1 licence

Although the majority of respondents were living with at least one parent, the results indicate that parental involvement on the P1 period is fairly minimal; the majority of respondents reported not driving with a fully licensed driver since being on their Ps and of the respondents who reported that their parents place restrictions on their driving the most common restriction was advising their parent where they are going. The question "*since being on your Ps have you driven a car with a fully licensed driver as a passenger"* does not specify the main supervisor, and it was the intention in survey development that by asking about driving experience on P1 with the main supervisor could be used as a broad indicator of parental involvement. It is suggested that this question should have instead focussed on the main supervisor (e.g. "*since being on your Ps have you driven with the main person who supervised you on your Ls"*) which might provide a more reliable, albeit broad, indicator of parental involvement. Increasing parental involvement for young novice drivers in the GLS is encouraged, particularly in the transition from Ls to P1. This is discussed further in Sections 8.3.2.2 and 8.3.2.3.

10.3.2.2 Peer passenger restriction issues

Respondents were more concerned with being detected by police rather than parents if they breached the peer passenger restriction. Few respondents reported that their friends often encouraged them to breach the peer passenger restriction, and few respondents had breached the peer passenger restriction unintentionally. Only half the respondents agreed or strongly agreed to the statement *I have no problem complying with the peer passenger restriction.* Almost half of the respondents reported that they have not been tempted to breach the peer passenger restriction, whereas 25% have breached and 25% have been tempted to breach the restriction.

The peer passenger restriction was the second most common licensing component that respondents commented on, and the clear majority of comments were negative suggesting that this restriction is both widely unaccepted by P1 drivers and is the GLS component that produces the highest level of negativity. A major objection to the peer passenger restriction was that it prevented P1 drivers from picking up their peers late at night. This suggests that the respondents considered themselves to be safe drivers and that they have failed to understand the risks involved in driving with peer passengers particularly at night. These objections could also be due to the belief that the peer passenger restriction is incongruous to the 'designated driver' message. It may be that an unintended consequence of the 'designated driver' message is that it is presumed that any sober driver is a safe designated driver, including P1 drivers, and therefore it may be erroneously assumed that P1 drivers are appropriate designated drivers.

To address these objections to the peer passenger restriction and the potential confusion with the 'designated driver' message it is suggested that awareness may need to be raised regarding the increased driving risk, particularly at night, during the P1 period with peers and hence the justification of the peer passenger restriction. Objections to and breaches of the peer passenger restriction are consistent with previous research, which has shown that although parents are in favour of the peer passenger restriction young drivers oppose the restriction and experience pressure from their peers to breach the restriction (Raymond, 2007). Therefore raising awareness of the role of the peer passenger restriction may be a difficult task to change young driver's attitudes and behaviour about the restriction.

Results indicated a clear shift in the pattern of vehicle ownership between the Ls and P1 period. Most respondents reported driving the family car owned by their parent(s) as a Learner driver but driving their own vehicle as a P1 driver. The next most common pattern was driving the family car owned by parent(s) during the Learner period but being allocated a different vehicle to drive that was still owned by their parent(s) on the P1 period. The findings indicate that young novice driver's progression from Ls to P1 is very likely to coincide with a change of vehicle to either a secondary family owned vehicle or their own vehicle. Survey results suggest that in either scenario, it is likely that the vehicle driven during the P1 period was likely to be older and cheaper than the vehicle driven in the Learner period. This is a key finding. Statistically the progression from Ls to P1 results in at least a 10-fold increase in crash involvement. The change in the vehicle driven between L and P1 phases may have important implications for the crash risk of newly licensed young novice drivers and certainly has an influence on the likelihood of injury in the crash.

The spike in crash risk that is observed from Ls to the first few months of the P1 period is generally attributed to inexperience and propensity to drive in high-risk driving situations (Gregersen & Bjurulf, 1996). It is argued that a change in vehicle ownership or the type of

vehicle driven should be considered a high-risk driving situation – it may increase a young novice driver's propensity to engage in poor driving behaviour and it may expose them to greater risk of having a crash due to poorer vehicle primary safety performance and greater risk of death or injury based on vehicle occupant protection performance (crashworthiness). GLS aims to reduce the sudden onset of exposure to high-risk driving situations, for example by enacting restrictions on the carriage of peer passengers or late night driving. To date GLS has generally ignored the role changing vehicle allocation may potentially have on crash and injury risk.

Further research should investigate whether vehicle ownership changes increases crash risk, and how the change in vehicle impacts their crash risk from a driver behaviour and vehicle safety perspective. Research should also investigate whether a change in vehicle ownership alone increases young novice driver crash risk irrespective of when this occurs in the GLS, or whether it is the change in vehicle ownership coupled with the transition from Ls to P1 that increases young novice driver crash risk. It may be that the change in vehicle from Ls to P1 has no impact on driving behaviour but the chosen vehicle is poor in terms of primary safety or crashworthiness. The impact on driving behaviour is beyond the scope of this paper and requires further research. The effect that vehicle ownership has in terms of vehicle safety is explored further.

Previous research has consistently found that vehicles that are typically driven by newly licensed young novice drivers provide poor crashworthiness in comparison to vehicles driven by drivers aged 25 years or above (Whelan et al. 2009; Watson & Newstead, 2009). At least in part then, vehicle safety is contributing to the high rate of deaths and serious injuries amongst P1 drivers. The survey undertaken in this study asked respondents about the make, model, and year of manufacture of their current vehicle and the vehicle that they drove on their Ls.

Whelan et al. (2009) provided encouraging results in terms of potential crash reductions if young novice drivers were driving safe vehicles (i.e. vehicles with the best possible crashworthiness within the identical vehicle market group and same year of manufacture to the vehicle the young novice driver crashed). The research evidence is mounting on the important role that vehicle safety plays among newly licensed drivers. The problem then becomes how vehicle choice can be influenced so that young novice drivers are driving safe vehicles, particularly in the first few months and years of independent driving. The vehicle ownership results of this study indicate that vehicle choice includes the allocation of vehicles to young novice drivers from their parents' pool of family vehicles, as well as traditional consumer vehicle choice in terms of the purchase of new or used vehicles.

Whelan et al. (2009) reported the top 10 most common vehicles crashed by young novice drivers with each vehicle's respective crashworthiness rating and current market value, and also the safest vehicle alternatives (within the same vehicle market group and year of manufacture of all crashed vehicles) with each vehicle's crashworthiness ratings and used vehicle purchase price range. Further inspection of this data indicates that the 10 most common vehicles crashed by young novice drivers belong predominantly to four market groups; large, medium, small, and light (Used Car Safety Ratings brochure, 2010). The average crashworthiness rating (risk of death or serious injury given crash involvement) for the vehicles that are most commonly crashed by young novice drivers is 4.26% and the purchase price for these vehicles ranges from an average of $1,081-$3,859. The average

crashworthiness rating for the safer vehicle alternatives across the four vehicle market groups is 1.59% and the purchase price for these vehicles ranges from an average of $7,522-$12,513.

The average vehicle purchase for safer vehicle alternatives is around $10,000, which is consistent with the results of the current study where 70% of respondents either expected to pay or actually paid up to $10,000 for their vehicle which is very close to the purchase price that a young novice driver has actually paid or would expect to pay. A sample bias among respondents has already been identified in that it is considered that they were more safety-conscious than non-respondents due to the very low number of infringements and Police-reported crashes among respondents. It is unclear how this sample bias translates to socio-economic status and the associated factor of income available for vehicle purchase. It may be that there is a correlation in that highly safety-conscious drivers also come from a relatively high SES, which would suggest that the average available budget for P1 drivers ($10,000) as calculated from the survey responses is lower for the population of all P1 drivers in Queensland.

This indicates that vehicle purchase price is not likely to be a barrier for young novice drivers to choose safer vehicle alternatives. The survey results demonstrate that vehicle purchase price is the most critical factor influencing vehicle choice and resale value the least important factor. It also showed that respondents either expect to pay or actually pay for their vehicle with their own savings, with receiving money from parents (either in full or a proportion) also fairly common. It was uncommon for respondents to report receiving finance, thus reducing the efficacy of targeting finance companies to encourage safer vehicle purchase for young novice drivers. As most respondents were living with at least one of their parents it is highly likely that parental involvement is involved during the process of P1 drivers purchasing a vehicle, and it is arguably impossible for no parental involvement among those P1 drivers who reported driving another family vehicle allocated to them but owned by their parents.

The development of strategies that target both the parent and the young novice driver so that they are informed of the safest vehicle choices and can avoid making poor decisions should be considered. The development of information on safe vehicle purchase through websites and brochures is important but the promotion of these information sources timed prior to vehicle purchase is critical. One source of information can be found on the newly developed *First Car List* which is a two-page document available online on the *Arrive Alive* website listing safe and affordable vehicles (Arrive Alive, 2010). Parents should be encouraged to lend their P1 driver the main family vehicle as this is most likely to be the safest vehicle in the family in terms of primary (crash avoidance) and secondary (injury mitigation) safety.

A further strategy for optimising young novice driver vehicle choice may be through the use of reduced insurance premiums for young novice drivers that encourage the purchase of vehicles with good crashworthiness. Following further research into vehicle ownership and allocation, reduced premiums for parents who lend the main family vehicle to their newly licensed drivers should also be explored. Reduced premiums or excesses could also apply to vehicles with smart key technology. Potentially the driving limits provided by the smart key technology could be based on the restrictions in the GLS (e.g. peer passenger restriction, zero BAC).

10.3.3 Summary of findings and future research

By sampling 5,000 newly licensed P1 drivers about their experiences on their Ls, level of parental involvement on P1, and vehicle safety factors has allowed insight into young novice drivers' attitudes towards a range of licensing and enforcement issues. The results should be interpreted with a degree of caution since the sample was not representative of the wider population of novice drivers. The non-representativeness of the sample is demonstrated by survey respondents (n=1,404) accounting for less than 15% of the total number of infringements and police-reported crashes in the invited sample (n=5,000).

There were a number of concerns about the new GLS raised by the survey. Although not representing the majority of learners, a proportion of the learner population enter false log book records or compromise the accuracy of recording by not entering records immediately after each driving session. Although finding obtaining the required hours of learning onerous, many learners reported exceeding the hours and estimating that they would have reached the 100 hours even if it was not a requirement. A concern for P drivers is their general unhappiness with the peer passenger restrictions and the high proportion that admit to having contemplated or actually having breached the peer passenger restriction. A further concern is the high propensity of P drivers who are never or rarely accompanied by an experienced driver once on their P licence meaning they go from fully supervised to fully unsupervised at the time of obtaining the P licence rather than a gradual transition. The one mitigating factor is there remains a high degree of accountability to parents on trip destination and timing on the P licence phase.

The analysis of respondents' comments at the end of the survey indicates that they were much more likely to comment on the logbook and peer passenger components of the licensing system, and the nature of these comments suggest that respondents do not accept the peer passenger restriction and to some extent the logbook requirement. It is interesting that these two licensing components received much more comments than other components. Relative to other GLS initiatives, such as the zero BAC limit for all Learner and Provisionally licensed licence holders, the peer passenger restriction and logbook requirement are new GLS components and this may influence the level of acceptance among novice drivers. It is also possible that the result is due to an artefact of the survey whereby respondents felt that there was insufficient coverage of these components in the body of the survey.

The vehicle purchase and ownership results suggest that at the same time that a young novice driver progresses through the GLS from the phases with the lowest to highest risk of crash involvement, they also transition from driving in a relatively safe vehicle owned by their parent(s) to a relatively unsafe vehicle owned either by themselves, or a secondary family vehicle allocated to them but owned by their parent(s), and, based on the method of payment for the vehicle it appears that their parents are not always directly involved in the vehicle purchase. Prior research has established that safer vehicle choices by young drivers could significantly reduce novice driver deaths and serious injuries. Based on this there appears to be significant trauma saving potential in improving novice driver behaviour and parental influence on behaviour with respect to choosing safer vehicles.

11 SECONDARY EVALUATION: HAZARD PERCEPTION TEST EVALUATION

11.1 INTRODUCTION AND METHOD

As discussed in Chapter 1 (see Section 2.5.13) the Hazard Perception Test (HPT) is an exit test for P1 drivers which must be passed in order to be eligible to apply for a P2 licence. The HPT comprises a series of video clips depicting traffic scenarios in which the P1 driver is required to identify hazards within an expected timeframe by moving and clicking on a mouse (Horswill, 2008). There are 15 video clips within each HPT, and they will vary in length from 10 to 60 seconds, and are ordered randomly. Within any given video clip, there may be none, one or many hazards to be identified.

When a hazard is presented it is defined by a series of invisible frames. These frames move logically with the hazard as it moves within the video clip. Each of these frames is defined by a time span and two (x,y) co-ordinates. To pass the test the P1 driver must be able to use the mouse to place their responses within the surrounding frame to accurately identify the hazard and with sufficient reaction time. This reaction time, after standardisation, is used to score part of the test.

It is beyond the scope of this report to outline the definitions of passing and failing the test as this is based on complex algorithms. At the broadest level drivers can fail the test through two performance measures - by either clicking on non-hazards (i.e. being inaccurate in their clicking), or by being too slow in responding to hazards.

Boufous et al. (2011) examined the relationship between test outcomes of the New South Wales GLS hazard perception test and crash risk in the following licence period using a prospective cohort study. After controlling for factors affecting crash risk unrelated to the HPT, such as socio-demographic and behavioural factors as well as factors related to driver learning experiences, analysis showed a relationship between failing the hazard perception test and higher crash risk in the following time period. Based on this, evaluation of the HPT component of the new Queensland GLS aimed to establish overall pass/fail rates and investigate whether there was a relationship between HPT performance and crash involvement on the P1 and P2 periods. Performance was dichotomised into poor and good based on whether the HPT was passed on the first attempt; poor performance was defined as failing the test on the first attempt and good performance was defined as passing the test on the first attempt. Consideration of crash occurrence after multiple failures was not feasible due to the limited quantities of crash data.

The extract of de-identified results from the HPT was from 1 July 2008 to 30 October 2010 and included 74,337 P1 drivers who had attempted the HPT at least once. De-identified police-reported crash data (as described in Section 3.3.4 was merged onto the HPT database to determine crash-involvement among P1 and P2 drivers who had sat the HPT.

The following data fields were used in the analysis:

Table 41: Data fields utilised in the HPT analysis

Data Field	Description	Descriptive statistics
Unique identifier	De-identified from original source	Sample size = 74,337
Exam type code	Out of a set of 60 videos randomly presented	60 clips
Start date	Date the participant began the exam	Range = 1/7/2008 to 30/10/2010. Mean number of days in between attempts to complete HPT was 8.26 days.
Exam result	Result from exam - pass or fail	Average number of failed exams = 1.4, Range of attempts = 1 - 30
Action status	Action status from exam – pass or fail	Of 74,337 individuals 65,535 have passed leaving 8,802 in the data set that still have not passed*
Total clicks on objects that were not hazards	Number of clicks in the non-hazard area of the exam for the whole exam	See Table 42
Total clicks on hazards that were hazards	Number of clicks on the hazards for the whole exam	See Table 42
Total number of clicks ignored	Number of clicks ignored, neither hazard nor non-hazard	See Table 42
Total number of clicks	Total number of clicks in the exam	See Table 42
Total number of hazards	Total number of hazards in the exam	See Table 42
Mark	Reaction time	See Table 42

*Of the 65,535 that have passed there were two cases where there was a duplicate ID code in the pass database. In the first case this was duplicated 4 times and in the second 2 times. Therefore the actual number of passed respondents should read 65,531 and total number that have still not passed as 8,806.

11.2 RESULTS

The data reported below provides an overview of the number of HPT attempts, the results of P1 drivers' raw scores for each attempt of the HPT, the pass/fail rate, and the average number of attempts required to pass the HPT.

Table 42: Average characteristics of the HPT by test outcome

11.3	Clicks on non-hazards	Clicks on hazards	Clicks ignored	Total clicks	Total hazards	Total identified hazards	Reaction time
Fail a*	0.91	19.96	3.61	24.49	13.67	13.67	7.4
Fail b**	8.28	64.58	40.73	113.6	14.75	14.75	6.35
Pass	0.10	23.45	3.72	27.28	14.75	14.75	6.64

*"Fail a" denotes drivers who failed based on reaction time being too slow, **"Fail b" denotes drivers who failed based on inaccurate clicking.

Table 43 displays the proportion of drivers passing and failing across each HPT attempt.

Table 43: Pass and fail rates by HPT attempt

Attempt #	Fail A	Fail B	Pass	Total
1	44.32%	1.45%	54.24%	100.00%
2	25.36%	1.53%	73.11%	100.00%
3	31.42%	1.62%	66.96%	100.00%
4	43.39%	1.26%	55.35%	100.00%
5	44.39%	0.83%	54.79%	100.00%
6	53.42%	1.71%	44.87%	100.00%
7	69.37%	3.60%	27.03%	100.00%
8	69.74%	2.63%	27.63%	100.00%
9	65.31%	0.00%	34.69%	100.00%
10	75.86%	0.00%	24.14%	100.00%
11	90.00%	0.00%	10.00%	100.00%
12	100.00%	0.00%	0.00%	100.00%
13	92.86%	0.00%	7.14%	100.00%
14	92.31%	0.00%	7.69%	100.00%
15	83.33%	0.00%	16.67%	100.00%
16	80.00%	0.00%	20.00%	100.00%
17	100.00%	0.00%	0.00%	100.00%
18	100.00%	0.00%	0.00%	100.00%
19	62.50%	0.00%	37.50%	100.00%
20	80.00%	0.00%	20.00%	100.00%
21	75.00%	0.00%	25.00%	100.00%
22	100.00%	0.00%	0.00%	100.00%
23	100.00%	0.00%	0.00%	100.00%
24	100.00%	0.00%	0.00%	100.00%
25	100.00%	0.00%	0.00%	100.00%
26	100.00%	0.00%	0.00%	100.00%
27	100.00%	0.00%	0.00%	100.00%
28	100.00%	0.00%	0.00%	100.00%
29	100.00%	0.00%	0.00%	100.00%
30	0.00%	0.00%	100.00%	100.00%

The information in Table 43 is also presented in **Figure *20*** (with the data being restricted to 5 attempts or less).

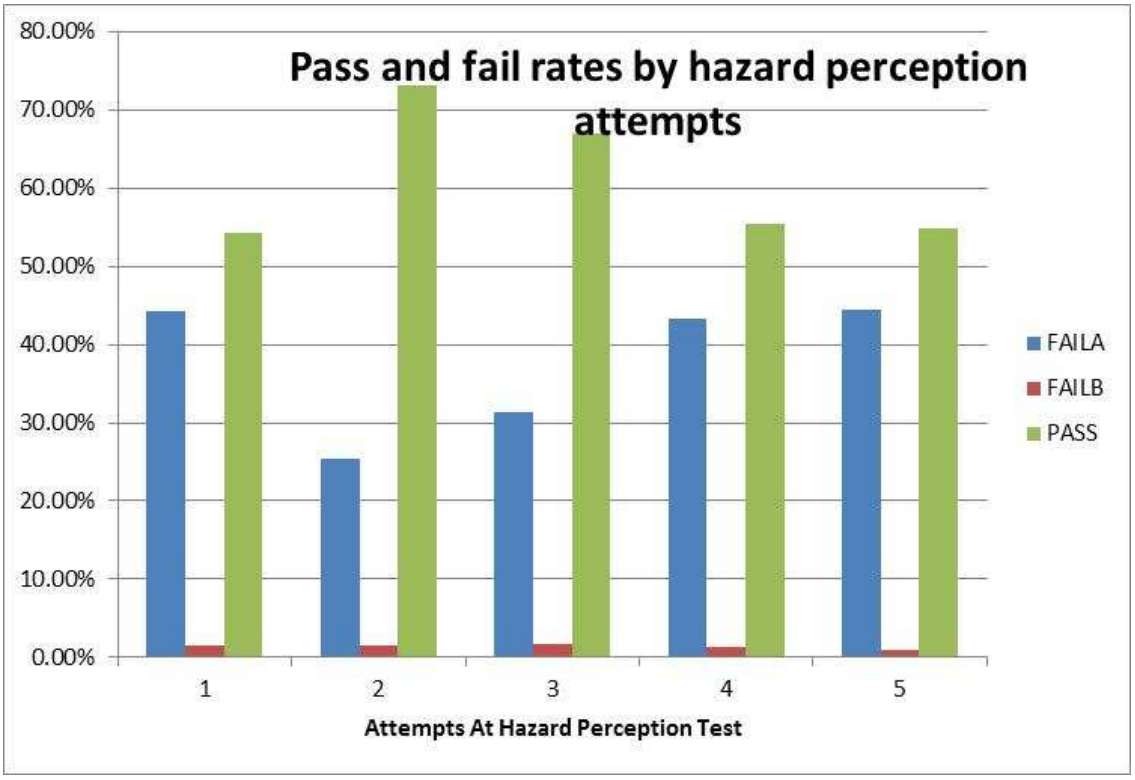


Figure 20: Pass/fail rate by 5 or less HPT attempts.

The number and proportion of crash-involved drivers who have sat the HPT is displayed in Table 44.

Table 44: Crash-involved drivers who have sat the HPT

	Non-crash involved	Had crash on P1	Had crash on P2	Had crash other licence phase	Total
Passed on first attempt	34, 820 (92.8%)	1,752 (4.7%)	598 (1.6%)	342 (0.9%)	37, 512 (100%)
Failed on first attempt	31, 549 (92.5%)	1,637 (5.2%)	421 (1.3%)	303 (1%)	33, 910 (100%)
Total	66, 369 (92.9%)	3,389 (4.7%)	1,019 (1.4%)	645 (0.9%)	71, 422 (100%)

11.4 DISCUSSION

The evaluation of the HPT has calculated the pass/fail rate and investigated whether there was any relationship between HPT performance and crash-involvement. Of the 70,000+ drivers who have sat the HPT between 1 July 2008 and 30 October 2010 there were up to 30 attempts to pass the HPT, with a mean of 1.4 failed attempts. Just over half of all drivers who sat the test passed on the first attempt. When drivers failed the test it was most likely due to reasons of clicking too slowly compared to clicking inaccurately. Based on comparing the proportion of crash-involved vs. non-crash-involved drivers by their outcome on first attempt of the HPT it appears that there is no relationship between crash-involvement and poor HPT performance.

These results indicate that almost half of all drivers fail the test on the first attempt because they are too slow at identifying hazards, however in terms of crash-involvement drivers' performance on the test as defined for the evaluation is unrelated to whether they are crash-involved on the P1 period (i.e. retrospective to sitting the HPT), or P2 period (i.e. prospectively after passing the HPT) or on another licence period (i.e. on the Open or Learner licence). The crash-involvement results suggest that based on the metric of performance considered the HPT does not have high specificity as screening test to assess driver's capabilities to exit the P1 phase. Whether some other metric of performance might have greater specificity remains to be established.

While a range of research has been undertaken into hazard perception as a cognitive driving skill in laboratory settings (see Whelan, Senserrick, Groeger, Triggs & Hosking, 2004), very few studies have evaluated this critical driving skill within the context of a state licensing test and its relationship to crash-involvement. In Victoria a study analysed involvement in police-reported crashes and performance on the VicRoads HPT (Allen, 1999, cited in Christie, 2000) and found a correlation whereby those with low HPT scores were more likely to be involved in fatal or serious-injury crashes than those with higher HPT scores. This in contrast to the findings of the current study, which used a different measure of test performance, and as a result further specific in-depth analysis is required on Queensland's HPT due to a number of limitations of the evaluation reported here.

The lack of crash data limits the extent to which these results can be used to guide policy. For example, the HPT extract was from July 2008 to October 2010, however the crash data was only available until December 2009 for police-reported crashes of all severity, December 2010 for hospitalisation police-reported crashes, and, November 2011 for fatal police-reported crashes. This limits the analysis particularly for crashes in the period after the driver has passed the HPT (i.e. the P2 and Open licence phases).

Christie has estimated that while the implementation of a HPT within a GDLS could cost between $500K-1M, the "breakeven cost" for the introduction of HPT could equate to one fatal crash or about seven serious injury crashes (based on community cost of $850K for a fatality and $130K for a serious injury crash) (Christie, 2000). Even though the results of the current evaluation of Queensland's HPT are considered preliminary the likely cost benefits as estimated by Christie are probably not being achieved in the Queensland HPT.

A more comprehensive analysis of the HPT is required including a full psychometric analysis on the validity and reliability of the HPT, and specifically the predictive validity of the HPT in terms of crash-involvement on the P2 phase. A cost-benefit analysis could also provide guidance for policy changes.

One outstanding issue that should be investigated is the timing of the HPT within the licensing system. It has been argued that the HPT be placed towards the end of the GDLS (Catchpole, Cairney & Macdonald, 1994, cited in Christie, 2000) and this is consistent with the placement of the HPT within the Queensland licensing system. However it should be noted that for the HPT in Victoria the test is placed at the end of the Learner period rather than at the end of the provisionally licensed period because "political and economic concerns about the retesting of already licensed drivers resulted in the HPT being incorporated into the provisionally licensed licence testing regime" (Christie, 2000, p22).

Whilst the hazard perception is one of the few driving skills that are considered to have a strong relationship to crash-involvement (MacDonald, 1987) this evaluation has found no relationship between crash-involvement and poor performance on the Queensland hazard perception test as measured by the metric used in the evaluation which suggests that further research is required to comprehensively evaluate the HPT after sufficient accumulation of police-reported crash data.

12 SECONDARY EVALUATION: DRIVER'S LICENCE HOLDING LAW FOR MOTORCYCLISTS

12.1 INTRODUCTION AND METHOD

12.1.1 Aims and Methodology Overview

The aim of this secondary evaluation analysis was to assess the effectiveness of the new law requiring that all learner Motorcyclists must have held a car licence for 12-months prior to obtaining their Learner rider licence. This component of the new GLS has been evaluated by comparing crash rates of those who are bound by the new law compared to those pre-implementation of the GLS in July 2007 who would have otherwise been affected by the law (i.e. prior to obtaining a Learner rider licence they did not obtain a car licence, or did not hold a car licence for all of the 12-months prior) and those who naturally adhered to the law (i.e. they had a car licence for at least 12 months prior to obtaining their Learner rider licence).

The evaluation shares many similarities to the Primary Evaluation in that treatment and comparison groups were defined and crash rates were calculated based on Police-reported crashes within treatment groups and for exposure of per months licensed. The crash and licensing data used in the analysis were from the same data extraction as described in the Primary Evaluation. Therefore for further details on the fundamental framework of the evaluation see Chapter 3.

12.1.2 Defining Treatment and Comparison Groups

The following motorcycle treatment and control study groups were defined.

Treatment Group 1: any motorcyclist who obtained their Learner rider licence for the first time post-1 July 2007 and were therefore required to hold a car licence for 12-months prior;

Treatment Group 2: any motorcyclist who obtained their Learner rider licence pre-1 July 2007 and did not hold a car licence for all of the 12-months prior to obtaining their rider Ls;

Treatment Group 3: any motorcyclist who obtained their Learner rider licence pre-1 July 2007 and held a car licence for all of the 12-months prior to obtaining their rider Ls; and,

Comparison group: any motorcyclist who held their Open rider licence and was aged between 25- and 35-years during the study period of July 2004 – November 2011.

12.1.3 Calculating Rider Crash rates

12.1.3.1 Exposure data

The licensing data was prepared for riders in the treatment and comparison groups by running frequency tables in SPSS for each group by start dates (in *month/year* format) in order to calculate exposure. Exposure data for the treatment group was based on one year of data post-obtaining a rider Learner Licence. That is, riders in each of the treatment groups were tracked for one year. Exposure for the comparison group was estimated based on the time on an Open Licence between the ages of 25 and 35 during the study period of July 2004 – November 2011 (i.e. the period when crash data was provided for police-reported fatal crashes). The categorisation of riders by the various pathways in the licensing system was not a focus in this evaluation, in contrast with the Primary Evaluation. Rather, the focus was to identify crashes occurring post-obtaining rider Ls (learner licence) regardless of the licence level that

the rider had progressed to. The methodology and calculation for rider exposure was identical to drivers when preparing the data for the Primary Evaluation (see Section 3.3.3).

12.1.3.2 Police-reported crash data

Police-reported crash data used in the evaluation of the driver licence holding law for motorcyclists was identical to the extract used in the Primary Evaluation. The data was limited to motorcycle crashes only, and the number of crashes in the first year of obtaining the rider Ls was generated for treatment and comparison groups.

For each group the crash rates per 10,000 licence months of exposure were calculated as follows:

Crash rate per month = 10,000 x (monthly crash frequency) / (person months of licence exposure).

12.1.4 Analysis Design

The analysis design was similar to the Primary Evaluation in crashes for the treatment and comparison groups were compared pre- and post- the implementation of the new GLS. The analysis framework is depicted in Table 45 below.

Like previous analyses in this evaluation of the new Queensland GLS, there are two possible measurements of the crash effects associated with the revised motorcycle licensing restrictions. The first is a measurement of the total impact of introducing the new GLS on novice motorcyclist crash rates from July 1st 2007. This involved comparing the average crash rates across all novice motorcyclists in the period prior to the new GLS (comprising Treatment Groups 2 and 3) to the average crash rate across all novice motorcyclists after the GLS introduction (comprising Treatment Groups 1, 2 & 3) to parallel changes in the comparison group of motorcyclists.

The second measurement is of the pure effect of changing the motorcycle licensing requirements on only the group affected by the change, which is Treatment Group 1. To measure this effect the crash rate prior to the new GLS for Treatment Group 2 was compared with the crash rate for Treatment Group 1 after GLS introduction with the open licence comparison group again used to adjust for non GLS related confounding effects. Treatment Group 1 is the group where licensing is affected by the new GLS licensing requirement. Treatment 2 was considered the most relevant pre GLS group for comparison as this is motorcyclists who obtained their learner licence without having held a car licence for 12 months at least. It should be noted that without the new GLS licensing requirement, not all those in Treatment Group 1 would necessarily have not held a car licence for at least 12 months before getting their motorcycle learner licence as demonstrated by the exposure in Treatment Group 3 who already conformed with the new GLS regulation. Consequently the second analysis represents the reduction in crash risk associated with having a car licence for 12 months prior to learner motorcycling compared to not having this car driving experience.

Table 45: Analysis design for drivers' licence holding law for Learner motorcyclists

	Pre New GLS			Post New GLS	
Design Group	**Licence Phase**	**Treatment Group**		**Licence Phase**	**Treatment Group**
Comparison	Open	Comparison		Open	Comparison
L Year 1	L	TG2		L	TG1
	L	TG3			
L year 1				TG2	Old GLS Group
				TG3	Old GLS Group

12.2 RESULTS AND DISCUSSION

The base crash and exposure data on which the analysis of the new GLS motorcycling licensing requirements was conducted are given in Appendix D by crash severity following the format of Table 45. The table of data for all reported crashes is also given in Table 46.

Table 46: Motorcycle exposure, crashes and crash rates before and after introduction of the new Queensland GLS: All Reported Crashes.

	Pre New GLS					Post New GLS			
Design Group	Licence Phase/Treatment Group	Exposure	Crashes	Crash rate		Licence Phase/ Treatment Group	Exposure	Crashes	Crash rate
Control	Open Control	1435869	590	4.1090		Open Control	869238	251	2.8876
First Year Riders	TG2	253790.5	70	2.75818		TG1	190738	104	5.4525
	TG3	205931.5	165	8.01237					
First Year Riders						TG2	57225	23	4.0192
						TG3	38835	25	6.4375

Prima facie, the data presented in Table 46 might suggest the new GLS regulations have had little effect on novice rider crash rates. Whilst the comparison group crash rates have fallen after the introduction of the new GLS, crash rates for each novice rider group have remained considerably higher after GLS introduction. With the group being affected by the new GLS requirement, TG1, having crash rates between the 2 groups continuing under pre new GLS requirements. However, examination of the data presented in Table 46 and Appendix D shows some unusual and unexpected trends which indicate some potential problems with the data.

Considering all reported crashes in Table 46, crash rates in the comparison group fell from 4.1 crashes per 10,000 licence months of exposure before the new GLS introduction to 2.9 crashes per 10,000 licence months of exposure after. Similarly large falls in the rate of fatal crashes were also seen in Appendix D (a reduction of over 50%). The fatal crash reduction is at odds with official Queensland motorcycle rider fatal crash reduction which showed no decrease in the annual number of rider fatalities over the period of data analysed in this study. Comparison group crash rates for experience motorcyclists in Table 46 are also significantly lower than for the car driver analysis comparison group in Table 10 which is contrary to expectation from other motorcycle research which suggest motorcycle crash risk is generally higher than car drivers per distance travelled. The measures presented in Table 46 for motorcyclists are not travel weighted however, being a simple measure of risk per licenced rider, the lack of travel exposure is likely to be explaining the discrepancy with the car driver risks. It is also possible the change in comparison group risk after introduction of the new GLS is partly a reflection of change in exposure over time although this cannot be verified. These anomalies highlight the importance that access to good quality travel exposure data might play in adequately assessing the effects of the new GLS on motorcycle crash rates.

Exposure changes might also explain some of the apparent anomalies in the treatment group crash rates in Table 46. In general the treatment group crash rates for novice drivers in Table 46 are higher than those for the comparison group as would be anticipated. The exception is TG2 which is the novice riders who have not held a car licence for at least 12 months before obtaining their learner permit prior to the new GLS. Noting the motivation of the GLS requirement for prior car licensure before a motorcycle licence is issued, it would be expected that crash rates for TG2 would be higher than those in TG3 in the pre new GLS period. Table 46 shows this was not the case with crash rates for TG 3 riders in the pre new GLS period which were nearly 3 times higher than the crash rates for TG 2. Examination of rider age at licensure shows TG3 riders were marginally older than TG2 riders meaning the result might reflect some age-related skill deficit for TG3 riders. However the age difference was very small with most riders first licensed between the age of 18 and 30. More likely, the difference in crash rate might reflect different exposure patterns for TG3 riders compared with TG2. Since TG3 riders also have a car licence it might reflect that they generally ride as a recreational activity, possibly in higher risk environments, or may in fact not ride at all. A process of identifying active motorcycle riders in the licensing data, perhaps through matching licence details to motorcycle ownership details, might be a way of overcoming this problem. Again, having relevant travel exposure data for each group would also inform the analysis.

The possible differences in rider motivation and exposure highlight further potential limitations in the analysis undertaken. Without easily being able to segregate the TG1 population into those who would have been TG2 equivalent and those who would have been TG3 equivalent (i.e. those who were forced by the new regulation to wait to get a motorcycle licence until having car driving experience) analysis of the data in Table 46 cannot estimate the pure effect of the regulation. This is a difficult limitation to overcome without understanding the individual motivations of newly licensed riders. Lack of detailed exposure data on motorcyclists by stage of riding also limits the potential to accurately estimate the effects of the new GLS. It is possible that introduction of the new GLS has significantly changed exposure patterns amongst novice riders. Exposure amongst the comparison group of riders may also have changed contributing to the general reduction in crash rates observed. Without having an understanding of these exposure changes, it is not possible to say with any certainty that the results from this analysis are not biased to some degree.

A final potential explanation for the apparently anomalous crash rates in Table 46 is the way in which data was extracted from the TMR licensing database for the analysis. Analysis of motorcycle crash rates has been carried out on the data set extracted for the car driver analysis. This data was extracted on the basis of dates which car driver learner permits were obtained for the treatment groups and ages in which open licenses were held for car drivers. The data extraction made no reference to motorcycle licensing dates. Hence the majority of data analysed for motorcyclists will only include those motorcyclists who have held a car licence prior to their motorcycle learner licence (TG3 and possibly the comparison group) or gone on to get a car licence at some stage (possibly all motorcycle treatment and control groups). Anyone who has only held a motorcycle licence may not appear in the data, which will impact most on identification of membership of TG2. Reflecting this, the sample or licensed riders in TG2 in the analysis data used is likely to be not representative of the full population of riders who should have been analysed as part of TG2. Table 46 only includes those riders who have gone on to get a car licence meaning they may not be those who found motorcycling an adequate mode of primary transport, suggesting limited exposure. This is a likely explanation behind the low per licence crash rates for TG2 in the pre GLS period of Table 46.

The bias in data extraction severely compromises the potential to use Table 46 data to estimate the effects of the new GLS on motorcycle crash rates since the comparison between pre GLS TG2 crash rates and post GLS TG1 crash rates is the most representative measure of the effects of the new GLS regulations for motorcyclists. Future attempts to analyse the effects of the new GLS on motorcycle crashes should be based on licensing data that has specifically been extracted on the basis of motorcyclists licensing history. If this can be achieved, the evaluation framework developed here would be a good basis for the analysis albeit still noting the requirements for adequate travel exposure data to fully control the analysis.

12.3 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, results of the analysis of changes in motorcycle crash rates associated with the introduction of the new GLS were inconclusive due to difficulties with the data available for the analysis. The crash rates that could be calculated from the available data are highly likely to be confounded by other factors which it has not been possible to measure. Principle amongst these is changes in travel exposure for specific novice rider groups which is not routinely collected and hence was not available for the analysis. This study highlights the need to have better exposure data on motorcyclists in order evaluate the effects of GLS regulations on novice motorcycle crash rates. It would allow understanding to be gained on how changes in exposure, both in total and to high risk situations, have changed over time and by rider group so this information can be included in the analysis. It would also facilitate a better understanding of broader rider behaviour and how this is influence by licensing conditions.

The final problem encountered in this analysis was the lack of licensing data for analysis that was extracted specifically for the evaluation of the new Queensland GLS on motorcycle crashes. Relying on data extracted based on a specification for car drivers proved inadequate. Any future evaluation of the effects of the crash effects of the new GLS should use specifications for motorcycle licensing data that is independent of the specification developed for the car driver data. This would allow successful application of the analysis framework developed here.

13 SUMMARY, CONCLUSIONS AND FURTHER RESEARCH

13.1 PRIMARY EVALUATION

This study has established an effective framework for comprehensive evaluation of the new Graduated Licensing System (GLS) introduced in Queensland on July 2007. It has the capacity to measure the effectiveness of the GLS both at the global level and within a range of specific levels of detail including by licence phase, licence phase progression groups and for specific elements of the GLS.

It was estimated that implementation of the new GLS in Queensland was associated with a 31% reduction in fatal crashes, a 13% reduction in fatal and serious injury crashes combined and a 4% reduction in all reported crashes, all of which were statistically significant.

Limited quantities of crash data from the period after the implementation of the new GLS on which the run the evaluation framework severely limited the range and robustness of crash effects which could be estimated for driver populations and elements of the new GLS. The results that could be obtained raised some concern that the crash reductions estimated for the GLS overall to date may not be sustained although confirmation of this will require further analysis at a future time when a longer period (2-3 further years) of data after GLS implementation are available for analysis.

13.2 SECONDARY EVALUATION

Secondary evaluation of the new Queensland GLS examined the effectiveness of a number of specific components of the system in greater detail on both crashes and intermediate measures of effectiveness including infringements, self-reported behaviours, hazard perception and vehicle choice. Key findings from the secondary evaluation are:

- The total number of offences detected related to new GLS driving conditions is very small as a proportion of the overall novice driver offence pool. This potentially suggests that novice drivers are relatively compliant with the new GLS regulations but more likely suggests that the intensity of enforcing GLS restrictions is not particularly high:
    - Enforcement of P plate display, peer passenger rules and late night driving curfews by police appears to be feasible, particularly when drivers are intercepted for other infringements.
    - Enforcement of the mobile phone rules, particularly related to supervisors and passengers, does not appear to be feasible.
    - Enforcement of the log book requirements also appears to be very lenient as learners who are considered to have falsified their logbook by Transport and Main Roads are provided the opportunity to rectify their logbook.
- Overall, introduction of the new GLS has been associated with a net reduction in the rate of all offences by novice drivers:
    - The exception to this is drink-driving where rates of offences have increased dramatically. This is most likely not due to the prevalence of drink driving amongst the novice driver population increasing but because of an increase

in the ability of the police to detect zero BAC breaches for provisionally licensed drivers due to them being readily identified with P plates. Blood alcohol test data recorded in the crash data supports this conclusion with the proportion of novice drivers involved in crashes with a non-zero blood alcohol concentration decreasing after introduction of the new GLS.

- P1 drivers were the only licence class to record an overall net increase in the rate of offending driven by increases in detections of unlicensed driving, hooning, drink driving and disobeying road signs.

- Older novice drivers who did not have to comply with all aspects of the new GLS also showed increases in their net rate of a number of serious offence types including hooning, drink driving and disobeying road signs.

- Those who progressed through all phases of the new GLS, representing the largest group of future novice drivers, recorded one of the largest decreases in overall offence rates and one of the smallest net increases in drink driving offences. Mobile phone offences were the only standout problem for this group.

- Self-reported behaviours and attitudes highlighted a number of issues about the new GLS:
  - Although not representing the majority of learners, a proportion of the learner population enter false log book records or compromise the accuracy of recording by not entering records immediately after each driving session.

  - Although finding obtaining the required hours of learning onerous, many learners reported exceeding the hours and estimating that they would have reached the 100 hours even if it was not a requirement. Furthermore, despite the requirement being considered onerous the majority reported that they thought that gaining the 100 hours made them a safer driver.

  - A concern for P drivers is their general unhappiness with the peer passenger restrictions and the high proportion that admit to having contemplated or actually having breached the peer passenger restriction. A further concern is the high propensity of P drivers who are never or rarely accompanied by an experienced driver once on their P licence, meaning they go from fully supervised to fully unsupervised at the time of obtaining the P licence rather than a gradual transition. The one mitigating factor is there remains a high degree of accountability to parents on trip destination and timing on the P licence phase.

  - Young novice drivers transition from driving a relatively safe vehicle owned by their parent(s) during the low crash risk learner phase to a relatively unsafe vehicle owned either by themselves, or a secondary family vehicle allocated to them but owned by their parent(s) in the high risk P licence phase contributing to poor road trauma outcomes

- The high-power vehicle restriction analysis indicated that restricted vehicles are relatively rare in the vehicle fleet and that only small reductions in police-reported crashes involving high powered vehicles (~1.4%) would result even with 100% compliance with the restriction which current data indicate is unlikely to be achieved.

It is also not possible to estimate the effects of crash migration to non high powered vehicles which may further reduce or possibly even negate the effects of the restriction. Consequently this aspect of the GLS is relatively ineffective in reducing novice driver road trauma.

- Evaluation of the effectiveness of peer passenger restrictions for P1 drivers was unable to establish any statistically significant effects of the restrictions on crash involvement and overall passenger injury rates however significant reductions in late night crash risk for both P1 and P2 drivers was measured. Analysis of infringement data and alcohol involvement in night time crashes suggests the majority of this reduction might have been attributable to more efficient enforcement of the requirement for zero blood alcohol and not the peer passenger restriction. Crash and self-reported data also suggest that compliance with peer passenger restrictions may be relatively poor.

- It was not possible to establish a general relationship between performance on the HPT and crash involvement. The HPT requires further more detailed investigation into its effectiveness

- Analysis of changes in motorcycle crash rates associated with the introduction of the new GLS was inconclusive. This is due in part due to the lack of travel exposure data biasing crash risk estimates which were based only on months of licensing. It was also due to licensing data being used for the analysis not being specified specifically for analysis of motorcycle licensing.

13.3 PRIORITIES FOR FURTHER RESEARCH

This initial evaluation of the new GLS implemented in Queensland implemented from July 2007 has identified a number of priorities for further research to more fully understand the magnitude of the impact and mechanisms of effectiveness of this important road safety initiative. They are listed as follows:

Further analysis of crash outcomes

A key recommendation from the study is that the evaluation of the new Queensland GLS using the framework developed in this study be revisited when 2 to 3 years of additional crash data are available. Significant quantities of additional crash data will enable the production of more robust and wide ranging estimates of crash effects associated with the GLS for both car drivers as well as motorcyclists. This is the most important priority for further research.

Collection of travel and exposure data specific to the new GLS and its components, such as the late night peer passenger restriction, would allow more definitive assessment if its effectiveness in combination with analysis of crash data.

Further analysis of enforcement and infringements

Analysis of the infringement data has been able to identify a number of effects associated with the new GLS introduction and has also raised some potential hypotheses around the reasons for the effectiveness or ineffectiveness of some of the GLS regulations as well as ability and capacity for some of the regulations to be enforced. Further research is required in this area to inform better development and enforcement of regulation for novice drivers. This includes:

- Research to understand the reason for the apparent lack of enforcement of regulations concerning passenger mobile phone restrictions and log book use. Research needs to identify the extent to which novice drivers adhere to these restrictions and whether adherence, if identified, is due to the existence of the law itself or pre-existing cultural acceptance of the regulations. Regarding enforcement of logbook requirements research is required to fully understand the process and effectiveness of logbook review in addition to reviewing internal coding practises in relation to logbook offences if a clear picture of the rate of this offence is to be gained.

- Further research is also required to specifically examine novice driver compliance with new GLS regulations more broadly. This could be achieved through either survey based methods or naturalistic driving study methods.

- Further specific research on police enforcement effort and practices is warranted to understand the rigour with which various GLS regulations are enforced, the efficiency of which offences are detected through the enforcement carried out and the specific deterrent mechanisms from the enforcement. Understanding how GLS elements such displaying P plates have assisted in effective enforcement will assist in optimising future enforcement efforts.

- Further survey or interview based research on novice drivers is also recommended to assist in understanding the deterrent mechanism each GLS element has had on various infringement types observed to have changed substantially in this research.

Motorcycles licensing:

This evaluation highlights the need for more in-depth understanding of novice motorcyclist behaviour. Key priorities include;

- Collection of comprehensive exposure data on motorcyclists in order to understand how changes in exposure, both in total and to high risk situations, has changed over time and by rider group and how these relate to patterns in crashes and infringements observed. This would include looking at exposure of all licenced motorcycle riders to establish which riders ride and when including identifying patterns of inactive and active riders. It would also look at a sample of active riders to identify their patterns of exposure.

- Research to better understand broader rider behaviour and how this is influence by licensing conditions.

Behaviours and attitudes

The relatively small survey of behaviour and attitudes to the new GLS centred on logbook use and acceptance has identified the potential to learn much more about novice drivers, and their behaviour and attitudes to the new GLS more broadly, through a much more extensive survey based approach. Aspects of novice driver behaviour and attitudes, particularly those specific to GLS regulations that could be explored or explored further as part of this research to include:

- The use of P plates and its influence on compliance with other GLS requirements

- Attitudes to and compliance with peer passenger restrictions and whether this has resulted in changes in the amount of travel exposure or the mode of transport used.

- Alcohol use and attitudes and compliance with the zero BAC requirement

- Log book practices and whether compliance and attitudes have changed over time

- Self and passenger mobile phone use

Further research on the choice and allocation of vehicles for novice drivers is also recommended. This should investigate aspects such as:

- Vehicle ownership or allocation and its relationship to crash risk, and how a change in vehicle impacts their crash risk from a driver behaviour and vehicle safety perspective particularly in transition from Ls to P1.

- How to optimise young novice driver vehicle choice through the use consumer information and potential incentives such as reduced insurance premiums to encourage the purchase of vehicles with good crashworthiness.

HPT

This evaluation has been unable to undertake a full and rigorous evaluation of the Queensland GLS HPT and its timing due to the inability to establish an effective evaluation design based on the HPT implementation. Further research is recommended to undertake a rigorous evaluation of the Queensland HPT to determine its detailed relationship with crash outcomes and to develop fully supported conclusions on its content and timing of delivery.

14 REFERENCES

Australasian Evaluation Society, (2006). *Guidelines for the ethical conduct of evaluations.* Accessed online www.aes.asn.au, September 2009.

Bates, L., Watson, B., & King, M. (2009). *Factors influencing learner driver experiences.* CARRSQ Report April 2009. Centre for Accident Research and Road Safety, Brisbane, Queensland.

Boufous, S., Ivers, R., Senserrick, T., Stevenson, M. (2011), Attempts at the practical on-road driving test and the hazard perception test and the risk of traffic crashes in young drivers. *Traffic Injury Prevention.* 12(5), 475-482.

Chen, L.H., Baker, S.P., & Guohua, L., (2006). Graduated driver licensing programs and fatal crashes of 16-year-old drivers: A national evaluation. *Paediatrics,* 118, 56-62.

Cooper, D., & Gillan, D., (2005). *Long term impacts of California's Graduated Licensing Law of 1998.* Institute of Transportation Studies University of California, Berkley.

Diamantopoulou, K., Skalova, M., Dyte, D. & Cameron, M. (1996). *Crash risks of road user groups in Victoria*. MUARC Report No. 88. Monash University Accident Research Centre, Clayton, VIC.

Foss, R., D, Goodwin, A.H., McCartt, A.T., & Hellinga, L.A. (2009). Short-term effects of a teenage driver cell phone restriction. *Accident Analysis and Prevention, 41,* 419-424.

Gregersen, N.P. (1997). *Evaluation of 16-years age limit for driver training: First report.* VTI Report 418A. Swedish National Road and Transport Research Institute, Linkoping, Sweden.

Gregersen, N.P., & Bjurulf, P. (1996). Young Novice Drivers: Towards a model of their accident involvement. *Accident Analysis & Prevention, 28,* 229-246.

Hartling, L., Wiebe, N., Russell, K., Petruk, J., Spinola, C., & Klassen, T.P., (2004). Graduated driver licensing for reducing motor vehicle crashes among young drivers (Review). *The Cochrane Library,* Issue 4.

Haworth, N., & Mulvihill, C. (2005). Review of motorcycle licensing and training. MUARC Report 240, Monash University Accident Research Centre, Clayton, Victoria.

Hingson, R., Howland, J., Koepsell, T.D., & Cummings, P. (2001). Case-control studies in injury research, in *Injury Control: A guide to research and program evaluation.* Rivara, F.P., Grossman, D.C., Cummings, P., Maier, R.V., & Koepsell, T.D., Eds. Cambridge University Press.

Hyde, L.K., Cook, L.J., Knight, S.K., & Olsen, L.M. Graduated driver licensing in Utah: Is it effective? *Annals of Emergency Medicine,* 45 (2), 147-154.

Imai, S., & Mansfield, C.J., (2008). Disparities in motor vehicle crash fatalities of young drivers in North Carolina. *North Carolina Medical Journal, 69 (3),* 182-187.

Keall MD, Newstead S (2011) Potential safety benefits of restricting young drivers from driving high performance vehicles: analysis of Australian and New Zealand crash and licensing data. Monash University Accident Research Centre, Melbourne.

Kellerman, A.L., Rios, A., Wald, M., Nelson, S.R., Dark, K., & Price, M.E., (2007). *Graduated driver licensing in Georgia: The impact of the Teenage and Adult Driver Responsibility Act (TADRA).*Department of Emergency Medicine and The Emory Centre for Injury Control, Atlanta.

Margolis, L.G., Masten, S.V., & Foss R.D. (2007). The effecsts of graduated driver licensing on hospitalization rates and charges for 16- and 17-year-olds in North Carolina. *Traffic Injury Prevention, 8,* 35-80.

Masten, S.V., & Hagge, R.A., (2004). Evaluation of California's graduated driver licensing program. *Journal of Safety Research,* 35, 523-535.

Mayhew, D., Simpson, H.M., Singhal, D., & Desmond, K., (2006). *Reducing the crash risk for young drivers.* Report prepared for the Foundation for Traffic Safety, Washington DC.

McCartt, A.T., Teoh, E.R., Fields, M., Braitman, K.A., & Hellinga, L.A., (2009). *Graduated licensing laws and fatal crashes of teenage drivers: A national study.* Insurance Institute for Highway Safety, Arlington.

McKnight, A.J. & Peck, R.C. (2002). Graduated driver licensing: what works? *Injury Prevention, 8(Suppl II),* 32-38.

Morrisey, M.A., Grabowski, D.C., Dee, T.S., & Campbell, C., (2006). The strength of graduated driver licence programs and fatalities among teen drivers and passengers. *Accident Analysis and Prevention,* 38, 135-141.

National Highway Traffic Safety Administration (1998). *Saving teenage lives: the case for graduated licensing*. US Department of Transportation. http://www.nhtsa.dot.gov/people/injury/newdriver/SaveTeens/Index.html.

Palamara P, Gavin A (2005) The Relationship Between Vehicle Power to Weight Ratio and Young Driver Crash Involvement, Report No. RR157, Report to the Road Safety Council of Western Australia. Injury Research Centre, The University of Western Australia.

Palamara, P., (2007). *The Graduated driver training and licensing program evaluation: Review of the learner-driver supervised driving logbook component, OR 12.* Injury Research Centre, School of Population Health, University of Western Australia.

Queensland Transport, (2007). *Safe driving in Queensland: Learner driver handbook.* Queensland Government: Queensland Transport, Brisbane.

Raymond, P., Johns, M., Golembiewski, G., Furst Seifert, R Nichols, J., & Knoblauch, R., (2007). *Evaluation of Oregon's Graduated Driver Licensing Program.* US Department of Transportation, National Highway Traffic Safety Administration, Washington DC.

Rice, T.M., Peek-Asa, C., & Krauss, J.F., (2004). Effects of the Californian graduated driver licensing program. *Journal of Safety Research, 35,* 375-381.

Scuffham, P. A., & Langley, J. D. (2002). A model of traffic crashes in New Zealand. *Accident Analysis & Prevention, 34*(2002), 673-687.

Senserrick T.M., & Whelan M.I. (2003). *Graduated driver licensing: Effectiveness of systems and individual components.* MUARC Report 209, Monash University Accident Research Centre, Clayton, Victoria.

Shope, J.T., & Molnar, L.J., (2004). Michigan's graduated driver licensing program: Evaluation of the first four years. *Journal of Safety Research, 35,* 337-344.

Simpson, H.M. (2003). The evolution and effectiveness of graduated licensing. *Journal of Safety Research, 34,* 25-34.

Thompson, R.S., & Sacks, J.J., (2001). Evaluating an injury intervention or program, in *Injury Control: A guide to research and program evaluation.* Rivara, F.P., Grossman, D.C., Cummings, P., Maier, R.V., & Koepsell, T.D., Eds. Cambridge University Press.

VicRoads (2002). *'arrive alive! 2002-2007', Victoria's Road Safety Strategy*. VicRoads: Kew, Victoria.

Whelan, M., Scully, J. and Newstead, S. (2009) *Vehicle safety and young drivers Stages 2 and 3: Analysis of young driver crash types and vehicle choice optimisation* Report 292, Monash University Accident Research Centre, Melbourne, Australia.

Waller, P.F. (2003). The genesis of GDL. *Journal of Safety Research, 34,* 17-23.

Wiggins, S., (2004). *Graduated licensing program: Interim evaluation report – Year 3.* Insurance Corporation of British Columbia.

Williams, A.F, Ferguson, S.A., & McCartt, A.T., (2007). Passenger effects on teenage driving and opportunities for reducing the risks of such travel. *Journal of Safety Research,* 38, 381-390.

Williams, A.F, Ferguson, S.A., & Wells, J.K., (2005). Sixteen-year-old drivers in fatal crashes, United States, 2003. *Traffic Injury Prevention,* 6, 202-206.

World Health Organisation (2007). *Youth and road safety.* World Health Organisation, Geneva, Switzerland.

APPENDIX A

The following major road safety initiatives have been developed and introduced both prior to and after the implementation of the GLS, including:

1. Random roadside drug driving tests;
2. Reforms to the Q-Ride motorcycle licensing system;
3. Cumulative Disqualifications (disqualifications for drug and alcohol offences are now served one after the other);
4. The commencement of Motorbike Safety reforms including new rules around RE to R class progression and introducing a minimum pillion passenger age (8 years);
5. The expansion and maximisation of the Speed Camera Program including introduction of fixed speed cameras in three locations;
6. Introduction of double demerit points for a second and subsequent speeding offence more than 20km/h over the speed limit within 12 months;
7. The introduction of immediate suspensions for high-risk, repeat drink drivers;
8. The introduction of new demerit point offences for heavy vehicle drivers who commit logbook and driving hour offences;
9. The introduction of new penalties and sanctions for driver distraction, inattention and aggression;
10. Implementation of a number of reforms to the Q-Ride, motorcycle training and assessment program in December 2007; and
11. Implementation of state-wide vehicle impoundment laws on 1 July 2008 for repeat offenders who drive an unregistered and uninsured vehicle; drive while unlicensed or disqualified; high-level drink drive; fail to supply a specimen of breath or blood; drive under a 24-hour suspension; or drive an illegally modified vehicle.

APPENDIX B: INFRINGEMENTS

	Pre											Post										
Design Group		All Offences	Disobey Road Signage	Drink Driving	Hooning	Mobile phone	Other	Seatbelt	Speeding	Unaccompanied Learner	Unlicensed/Disqualified		All Offences	Disobey Road Signage	Drink Driving	Hooning	Mobile phone	Other	Seatbelt	Speeding	Unaccompanied Learner	Unlicensed/Disqualified
C	Comparison	236.5	14.9	9.6	0.0	7.0	23.8	23.8	168.0	0.0	5.7	Comparison	262.6	11.7	7.1	0.0	12.7	23.5	23.5	195.2	0.0	7.0
L	L (old)	175.6	3.6	4.3	0.0	0.5	60.2	5.1	19.3	76.8	5.6	L TG1	61.4	1.1	1.9	0.0	0.2	26.6	1.9	6.3	21.7	1.7
												L TG2	228.5	2.6	4.1	0.0	0.0	99.0	3.1	33.2	81.4	5.2
												L TG3	223.0	5.4	4.0	0.7	0.0	91.6	3.4	27.0	86.2	5.4
												L TG4	260.1	5.9	4.9	0.5	2.2	107.1	3.2	28.9	95.7	12.2
												L TG5	191.9	3.8	4.0	0.1	1.4	72.1	3.5	25.0	77.7	4.5
												L TG6	108.8	2.3	5.2	0.0	0.5	42.2	2.2	16.5	27.6	12.3
L7	L (old) TG7	135.9	2.4	7.6	0.1	0.5	50.1	3.8	12.6	54.1	4.8	L (old) TG7	147.1	2.3	4.8	0.0	0.7	59.0	0.0	13.6	54.6	7.3
L8	L (old) TG8	250.1	3.7	14.3	0.0	0.9	91.3	5.0	29.0	80.4	25.5	L (old) TG8	265.8	3.4	4.9	3.4	1.5	110.5	0.0	26.9	97.4	16.1
L9	L (old) TG9	310.4	6.2	17.3	0.0	1.2	102.0	8.2	39.0	98.3	38.0	L (old) TG9	330.5	5.8	6.6	0.0	2.2	127.1	0.0	34.7	123.1	24.7
L10	L (old) TG10	354.0	6.3	23.9	0.1	1.1	118.2	10.0	42.1	121.4	30.9	L (old) TG10	194.5	3.5	12.0	0.0	1.0	61.9	0.0	27.6	46.5	37.3
L												L (old)	227.8	3.5	12.9	0.0	2.3	84.1	0.0	63.1	45.6	15.2
P1	P 1st Yr Old GLS	348.2	4.1	18.3	0.5	6.5	76.1	12.4	197.8		9.0	P1 TG1	366.9	20.3	27.1	0.2	10.6	88.1	9.0	218.4		12.3
												P1 TG2	290.7	16.5	96.5	0.0	7.7	53.8	5.5	186.5		16.5
												P1 TG3	313.4	26.2	99.1	0.0	5.8	53.9	1.5	212.8		10.2
												P1 TG7	371.7	20.3	65.0	0.2	10.3	84.9	11.5	198.4		25.7
												P1 TG8	547.7	31.9	115.4	26.3	12.0	80.3	11.5	367.1		28.6
P1												P 1st Yr Old GLS	367.3	0.1	808.2	0.3	11.2	78.3	14.3	208.5		14.4
P2	P 2nd yr+	363.0	19.4	19.4	0.5	9.5	72.9	14.1	206.2		19.4	P2 TG1	283.3	12.7	23.7	0.1	30.5	54.4	6.2	190.2		5.6
												P2 TG2	282.8	14.4	210.9	0.0	14.4	67.1	0.0	187.0		0.0
												P2 TG4	287.4	31.7	67.8	0.0	5.2	59.7	3.7	166.5		16.2
												P2 TG5	211.7	20.0	87.6	0.0	4.3	33.7	3.3	124.2		13.7
												P2 TG7	263.6	13.3	35.3	0.1	11.7	46.7	5.5	170.5		8.8
												P2 TG9	249.7	16.5	96.0	0.1	6.8	43.3	8.7	146.1		14.1
P2												P 2nd yr+	386.6	15.9	125.9	0.3	14.2	0.0	14.6	220.7		27.4
Open	Open Old GLS	308.2	23.5	24.9	0.0	7.5	43.5	12.7	181.7		12.6	Open TG1	285.6	14.5	0.0	0.0	13.5	27.0	4.3	225.2		1.3
												Open TG2	244.8	0.0	0.0	0.0	49.0	24.5	0.0	171.4		0.0
												Open TG3	254.5	16.2	0.0	0.0	16.2	32.5	5.4	173.3		10.8
												Open TG4	268.3	14.5	0.0	0.0	4.8	19.3	1.6	221.7		6.4
												Open TG5	276.1	22.5	4.7	0.0	8.4	28.9	3.8	194.1		12.7
												Open TG7	274.1	15.3	0.2	0.1	11.5	26.3	3.0	216.0		1.7
												Open TG8	280.2	19.3	2.9	0.0	5.8	29.4	4.8	208.4		9.6
												Open TG9	274.5	19.4	8.5	0.0	8.3	32.7	6.3	187.1		11.8
Open												Open Old GLS	323.9	16.1	8.8	0.1	13.8	35.3	7.5	233.0		8.9

Unlicensed/Disqualified

	Pre New GLS				Post New GLS			
Design Group		**Exposure**	**Unlicensed/Disqualified**	**Offence rate**		**Exposure**	**Unlicensed/Disqualified**	**Offence Rate**
Comparison	Open	14284773.5	8203	5.74	Open	19518950	13610	6.97
L	L (old) Old GLS Group	1394703	778	5.58	L TG1	2247509	393	1.75
					L TG2	19298	10	5.18
					L TG3	14841	8	5.39
					L TG4	36979.5	45	12.17
					L TG5	133189.5	60	4.50
					L TG6	2639898.5	3235	12.25
L7	L (old) TG7	351179	168	4.78	L (old) TG7	469465	345	7.35
L8	L (old) TG8	32103.5	82	25.54	L (old) TG8	26783.5	43	16.05
L9	L (old) TG9	326699	1243	38.05	L (old) TG9	249611	617	24.72
L10	L (old) TG10	327173.5	1010	30.87	L (old) TG10	1156324	4314	37.31
L					L (old) Old GLS Group	8558.5	13	15.19
P1	P First Year Old GLS Group	1217453.5	1100	9.04	P1 TG1	1565904.5	1919	12.25
					P1 TG2	9115	15	16.46
					P1 TG3	6859.5	7	10.20
					P1 TG7	955488.5	2452	25.66
					P1 TG8	21656	62	28.63
P1					P First Year Old GLS Group	352435	509	14.44
P2	P Second & sub years Old GLS Group	649248	1258	19.38	P2 TG1	896968.5	498	5.55
					P2 TG2	2086	0	0.00
					P2 TG4	13571.5	22	16.21
					P2 TG5	88456.5	121	13.68
					P2 TG7	879215	773	8.79
					P2 TG9	164024.5	231	14.08
P2					P Second & sub years Old GLS Group	2328972	6392	27.45
Open	Open Old GLS Group	244849	309	12.62	Open TG1	30423	4	1.31
					Open TG2	408.5	0	0.00
					Open TG3	1847	2	10.83
					Open TG4	6225.5	4	6.43
					Open TG5	65380.5	83	12.69
					Open TG7	230519.5	40	1.74
					Open TG8	20772.5	20	9.63
					Open TG9	277912.5	329	11.84
Open					Open Old GLS Group	4265866.5	3803	8.91

Unaccompanied Learner

	Pre New GLS				Post New GLS			
Design Group		**Exposure**	**Unaccompanied Learner**	**Offence rate**		**Exposure**	**Unaccompanied Learner**	**Offence Rate**
Comparison	Open	14284773.5	0	0.00	Open	19518950	0	0.00
L	L (old) Old GLS Group	1394703	10711	76.80	L TG1	2247509	4871	21.67
					L TG2	19298	157	81.36
					L TG3	14841	128	86.25
					L TG4	36979.5	354	95.73
					L TG5	133189.5	1035	77.71
					L TG6	2639898.5	7281	27.58
L7	L (old) TG7	351179	1901	54.13	L (old) TG7	469465	2564	54.62
L8	L (old) TG8	32103.5	258	80.37	L (old) TG8	26783.5	261	97.45
L9	L (old) TG9	326699	3213	98.35	L (old) TG9	249611	3072	123.07
L10	L (old) TG10	327173.5	3973	121.43	L (old) TG10	1156324	5372	46.46
L					L (old) Old GLS Group	8558.5	39	45.57
P1	P First Year Old GLS Group	1217453.5	0	0.00	P1 TG1	1565904.5	0	0.00
					P1 TG2	9115	0	0.00
					P1 TG3	6859.5	0	0.00
					P1 TG7	955488.5	0	0.00
					P1 TG8	21656	0	0.00
P1					P First Year Old GLS Group	352435	0	0.00
P2	P Second & sub years Old GLS Group	649248	0	0.00	P2 TG1	896968.5	0	0.00
					P2 TG2	2086	0	0.00
					P2 TG4	13571.5	0	0.00
					P2 TG5	88456.5	0	0.00
					P2 TG7	879215	0	0.00
					P2 TG9	164024.5	0	0.00
P2					P Second & sub years Old GLS Group	2328972	0	0.00
Open	Open Old GLS Group	244849	0	0.00	Open TG1	30423	0	0.00
					Open TG2	408.5	0	0.00
					Open TG3	1847	0	0.00
					Open TG4	6225.5	0	0.00
					Open TG5	65380.5	0	0.00
					Open TG7	230519.5	0	0.00
					Open TG8	20772.5	0	0.00
					Open TG9	277912.5	0	0.00
Open					Open Old GLS Group	4265866.5	0	0.00

Speeding

	Pre New GLS				Post New GLS			
Design Group		**Exposure**	**Speeding**	**Offence rate**		**Exposure**	**Speeding**	**Offence Rate**
Comparison	Open	14284773.5	239942	167.97	Open	19518950	380924	195.16
L	L (old) Old GLS Group	1394703	2697	19.34	L TG1	2247509	1408	6.26
					L TG2	19298	64	33.16
					L TG3	14841	40	26.95
					L TG4	36979.5	107	28.93
					L TG5	133189.5	333	25.00
					L TG6	2639898.5	4359	16.51
L7	L (old) TG7	351179	444	12.64	L (old) TG7	469465	640	13.63
L8	L (old) TG8	32103.5	93	28.97	L (old) TG8	26783.5	72	26.88
L9	L (old) TG9	326699	1275	39.03	L (old) TG9	249611	865	34.65
L10	L (old) TG10	327173.5	1378	42.12	L (old) TG10	1156324	3193	27.61
L					L (old) Old GLS Group	8558.5	54	63.10
P1	P First Year Old GLS Group	1217453.5	24078	197.77	P1 TG1	1565904.5	34194	218.37
					P1 TG2	9115	170	186.51
					P1 TG3	6859.5	146	212.84
					P1 TG7	955488.5	18954	198.37
					P1 TG8	21656	795	367.10
P1					P First Year Old GLS Group	352435	7349	208.52
P2	P Second & sub years Old GLS Group	649248	13388	206.21	P2 TG1	896968.5	17058	190.17
					P2 TG2	2086	39	186.96
					P2 TG4	13571.5	226	166.53
					P2 TG5	88456.5	1099	124.24
					P2 TG7	879215	14994	170.54
					P2 TG9	164024.5	2397	146.14
P2					P Second & sub years Old GLS Group	2328972	51398	220.69
Open	Open Old GLS Group	244849	4450	181.74	Open TG1	30423	685	225.16
					Open TG2	408.5	7	171.36
					Open TG3	1847	32	173.25
					Open TG4	6225.5	138	221.67
					Open TG5	65380.5	1269	194.09
					Open TG7	230519.5	4979	215.99
					Open TG8	20772.5	433	208.45
					Open TG9	277912.5	5200	187.11
Open					Open Old GLS Group	4265866.5	99381	232.97

Seatbelt

	Pre New GLS					Post New GLS			
Design Group		**Exposure**	**Seatbelt**	**Offence rate**			**Exposure**	**Seatbelt**	**Offence Rate**
Comparison	Open	14284773.5	33980	23.79		Open	19518950	45790	23.46
L	L (old) Old GLS Group	1394703	718	5.15		L TG1	2247509	430	1.91
						L TG2	19298	6	3.11
						L TG3	14841	5	3.37
						L TG4	36979.5	12	3.25
						L TG5	133189.5	46	3.45
						L TG6	2639898.5	579	2.19
L7	L (old) TG7	351179	133	3.79		L (old) TG7	469465	215	0.00
L8	L (old) TG8	32103.5	16	4.98		L (old) TG8	26783.5	14	0.00
L9	L (old) TG9	326699	269	8.23		L (old) TG9	249611	155	0.00
L10	L (old) TG10	327173.5	326	9.96		L (old) TG10	1156324	540	0.00
L						L (old) Old GLS Group	8558.5	0	0.00
P1	P First Year Old GLS Group	1217453.5	1510	12.40		P1 TG1	1565904.5	1414	9.03
						P1 TG2	9115	5	5.49
						P1 TG3	6859.5	1	1.46
						P1 TG7	955488.5	1101	11.52
						P1 TG8	21656	25	11.54
P1						P First Year Old GLS Group	352435	505	14.33
P2	P Second & sub years Old GLS Group	649248	915	14.09		P2 TG1	896968.5	559	6.23
						P2 TG2	2086	0	0.00
						P2 TG4	13571.5	5	3.68
						P2 TG5	88456.5	29	3.28
						P2 TG7	879215	486	5.53
						P2 TG9	164024.5	142	8.66
P2						P Second & sub years Old GLS Group	2328972	3405	14.62
Open	Open Old GLS Group	244849	310	12.66		Open TG1	30423	13	4.27
						Open TG2	408.5	0	0.00
						Open TG3	1847	1	5.41
						Open TG4	6225.5	1	1.61
						Open TG5	65380.5	25	3.82
						Open TG7	230519.5	70	3.04
						Open TG8	20772.5	10	4.81
						Open TG9	277912.5	175	6.30
Open						Open Old GLS Group	4265866.5	3219	7.55

Other

Design Group	Pre New GLS	Exposure	Other	Offence rate	Post New GLS	Exposure	Other	Offence Rate
Comparison	Open	14284773.5	33980	23.79	Open	19518950	45790	23.46
	L (old) Old GLS Group	1394703	8402	60.24	L TG1	2247509	5980	26.61
					L TG2	19298	191	98.97
L					L TG3	14841	136	91.64
					L TG4	36979.5	396	107.09
					L TG5	133189.5	960	72.08
					L TG6	2639898.5	11152	42.24
L7	L (old) TG7	351179	1759	50.09	L (old) TG7	469465	2770	59.00
L8	L (old) TG8	32103.5	293	91.27	L (old) TG8	26783.5	296	110.52
L9	L (old) TG9	326699	3331	101.96	L (old) TG9	249611	3173	127.12
L10	L (old) TG10	327173.5	3867	118.19	L (old) TG10	1156324	7161	61.93
L					L (old) Old GLS Group	8558.5	72	84.13
	P First Year Old GLS Group	1217453.5	9262	76.08	P1 TG1	1565904.5	13793	88.08
					P1 TG2	9115	49	53.76
P1					P1 TG3	6859.5	37	53.94
					P1 TG7	955488.5	8110	84.88
					P1 TG8	21656	174	80.35
P1					P First Year Old GLS Group	352435	2759	78.28
	P Second & sub years Old GLS Group	649248	4732	72.88	P2 TG1	896968.5	4882	54.43
					P2 TG2	2086	14	67.11
P2					P2 TG4	13571.5	81	59.68
					P2 TG5	88456.5	298	33.69
					P2 TG7	879215	4102	46.66
					P2 TG9	164024.5	711	43.35
P2					P Second & sub years Old GLS Group	2328972	16462	70.68
	Open Old GLS Group	244849	1064	43.46	Open TG1	30423	82	26.95
					Open TG2	408.5	1	24.48
					Open TG3	1847	6	32.49
Open					Open TG4	6225.5	12	19.28
					Open TG5	65380.5	189	28.91
					Open TG7	230519.5	606	26.29
					Open TG8	20772.5	61	29.37
					Open TG9	277912.5	908	32.67
Open					Open Old GLS Group	4265866.5	15076	35.34

Mobile phone

Design Group	Pre New GLS	Exposure	Mobile phone	Offence rate	Post New GLS	Exposure	Mobile phone	Offence Rate
Comparison	Open	14284773.5	10058	7.04	Open	19518950	24748	12.68
L	L (old) Old GLS Group	1394703	68	0.49	L TG1	2247509	36	0.16
					L TG2	19298	0	0.00
					L TG3	14841	0	0.00
					L TG4	36979.5	8	2.16
					L TG5	133189.5	18	1.35
					L TG6	2639898.5	140	0.53
L7	L (old) TG7	351179	16	0.46	L (old) TG7	469465	33	0.70
L8	L (old) TG8	32103.5	3	0.93	L (old) TG8	26783.5	4	1.49
L9	L (old) TG9	326699	40	1.22	L (old) TG9	249611	56	2.24
L10	L (old) TG10	327173.5	37	1.13	L (old) TG10	1156324	115	0.99
L					L (old) Old GLS Group	8558.5	2	2.34
P1	P First Year Old GLS Group	1217453.5	786	6.46	P1 TG1	1565904.5	1655	10.57
					P1 TG2	9115	7	7.68
					P1 TG3	6859.5	4	5.83
					P1 TG7	955488.5	987	10.33
					P1 TG8	21656	26	12.01
P1					P First Year Old GLS Group	352435	395	11.21
P2	P Second & sub years Old GLS Group	649248	614	9.46	P2 TG1	896968.5	2733	30.47
					P2 TG2	2086	3	14.38
					P2 TG4	13571.5	7	5.16
					P2 TG5	88456.5	38	4.30
					P2 TG7	879215	1026	11.67
					P2 TG9	164024.5	112	6.83
P2					P Second & sub years Old GLS Group	2328972	3300	14.17
Open	Open Old GLS Group	244849	184	7.51	Open TG1	30423	41	13.48
					Open TG2	408.5	2	48.96
					Open TG3	1847	3	16.24
					Open TG4	6225.5	3	4.82
					Open TG5	65380.5	55	8.41
					Open TG7	230519.5	264	11.45
					Open TG8	20772.5	12	5.78
					Open TG9	277912.5	230	8.28
Open					Open Old GLS Group	4265866.5	5877	13.78

Hooning

	Pre New GLS					Post New GLS			
Design Group		**Exposure**	**Hooning**	**Offence rate**			**Exposure**	**Hooning**	**Offence Rate**
Comparison	Open	14284773.5	55	0.04		Open	19518950	43	0.02
L	L (old) Old GLS Group	1394703	4	0.03		L TG1	2247509	2	0.01
						L TG2	19298	0	0.00
						L TG3	14841	1	0.67
						L TG4	36979.5	2	0.54
						L TG5	133189.5	1	0.08
						L TG6	2639898.5	2	0.01
L7	L (old) TG7	351179	2	0.06		L (old) TG7	469465	1	0.02
L8	L (old) TG8	32103.5	0	0.00		L (old) TG8	26783.5	9	3.36
L9	L (old) TG9	326699	1	0.03		L (old) TG9	249611	0	0.00
L10	L (old) TG10	327173.5	4	0.12		L (old) TG10	1156324	0	0.00
L						L (old) Old GLS Group	8558.5	0	0.00
P1	P First Year Old GLS Group	1217453.5	56	0.46		P1 TG1	1565904.5	34	0.22
						P1 TG2	9115	0	0.00
						P1 TG3	6859.5	0	0.00
						P1 TG7	955488.5	23	0.24
						P1 TG8	21656	57	26.32
P1						P First Year Old GLS Group	352435	12	0.34
P2	P Second & sub years Old GLS Group	649248	30	0.46		P2 TG1	896968.5	11	0.12
						P2 TG2	2086	0	0.00
						P2 TG4	13571.5	0	0.00
						P2 TG5	88456.5	0	0.00
						P2 TG7	879215	11	0.13
						P2 TG9	164024.5	1	0.06
P2						P Second & sub years Old GLS Group	2328972	74	0.32
Open	Open Old GLS Group	244849	0	0.00		Open TG1	30423	0	0.00
						Open TG2	408.5	0	0.00
						Open TG3	1847	0	0.00
						Open TG4	6225.5	0	0.00
						Open TG5	65380.5	0	0.00
						Open TG7	230519.5	2	0.09
						Open TG8	20772.5	0	0.00
						Open TG9	277912.5	0	0.00
Open						Open Old GLS Group	4265866.5	24	0.06

Drink Driving

	Pre New GLS					Post New GLS			
Design Group		**Exposure**	**Drink Driving**	**Offence rate**			**Exposure**	**Drink Driving**	**Offence Rate**
Comparison	Open	14284773.5	13764	9.64		Open	19518950	13854	7.10
L	L (old) Old GLS Group	1394703	606	4.35		L TG1	2247509	433	1.93
						L TG2	19298	8	4.15
						L TG3	14841	6	4.04
						L TG4	36979.5	18	4.87
						L TG5	133189.5	53	3.98
						L TG6	2639898.5	1363	5.16
L7	L (old) TG7	351179	267	7.60		L (old) TG7	469465	226	4.81
L8	L (old) TG8	32103.5	46	14.33		L (old) TG8	26783.5	13	4.85
L9	L (old) TG9	326699	566	17.32		L (old) TG9	249611	164	6.57
L10	L (old) TG10	327173.5	781	23.87		L (old) TG10	1156324	1388	12.00
L						L (old) Old GLS Group	8558.5	11	12.85
P1	P First Year Old GLS Group	1217453.5	2222	18.25		P1 TG1	1565904.5	4250	27.14
						P1 TG2	9115	88	96.54
						P1 TG3	6859.5	68	99.13
						P1 TG7	955488.5	6210	64.99
						P1 TG8	21656	250	115.44
P1						P First Year Old GLS Group	352435	28485	808.23
P2	P Second & sub years Old GLS Group	649248	1262	19.44		P2 TG1	896968.5	2125	23.69
						P2 TG2	2086	44	210.93
						P2 TG4	13571.5	92	67.79
						P2 TG5	88456.5	775	87.61
						P2 TG7	879215	3105	35.32
						P2 TG9	164024.5	1575	96.02
P2						P Second & sub years Old GLS Group	2328972	29320	125.89
Open	Open Old GLS Group	244849	610	24.91		Open TG1	30423	0	0.00
						Open TG2	408.5	0	0.00
						Open TG3	1847	0	0.00
						Open TG4	6225.5	0	0.00
						Open TG5	65380.5	31	4.74
						Open TG7	230519.5	5	0.22
						Open TG8	20772.5	6	2.89
						Open TG9	277912.5	237	8.53
Open						Open Old GLS Group	4265866.5	3739	8.76

Disobey Road Signage

	Pre New GLS					Post New GLS			
Design Group		**Exposure**	**Disobey Road Signage**	**Offence rate**			**Exposure**	**Disobey Road Signage**	**Offence Rate**
Comparison	Open	14284773.5	21283	14.90		Open	19518950	22913	11.74
L	L (old) Old GLS Group	1394703	504	3.61		L TG1	2247509	241	1.07
						L TG2	19298	5	2.59
						L TG3	14841	8	5.39
						L TG4	36979.5	22	5.95
						L TG5	133189.5	51	3.83
						L TG6	2639898.5	612	2.32
L7	L (old) TG7	351179	84	2.39		L (old) TG7	469465	109	2.32
L8	L (old) TG8	32103.5	12	3.74		L (old) TG8	26783.5	9	3.36
L9	L (old) TG9	326699	204	6.24		L (old) TG9	249611	146	5.85
L10	L (old) TG10	327173.5	207	6.33		L (old) TG10	1156324	401	3.47
L						L (old) Old GLS Group	8558.5	3	3.51
P1	P First Year Old GLS Group	1217453.5	504	4.14		P1 TG1	1565904.5	3173	20.26
						P1 TG2	9115	15	16.46
						P1 TG3	6859.5	18	26.24
						P1 TG7	955488.5	1943	20.34
						P1 TG8	21656	69	31.86
P1						P First Year Old GLS Group	352435	3	0.09
P2	P Second & sub years Old GLS Group	649248	1261	19.42		P2 TG1	896968.5	1135	12.65
						P2 TG2	2086	3	14.38
						P2 TG4	13571.5	43	31.68
						P2 TG5	88456.5	177	20.01
						P2 TG7	879215	1168	13.28
						P2 TG9	164024.5	270	16.46
P2						P Second & sub years Old GLS Group	2328972	3700	15.89
Open	Open Old GLS Group	244849	575	23.48		Open TG1	30423	44	14.46
						Open TG2	408.5	0	0.00
						Open TG3	1847	3	16.24
						Open TG4	6225.5	9	14.46
						Open TG5	65380.5	147	22.48
						Open TG7	230519.5	352	15.27
						Open TG8	20772.5	40	19.26
						Open TG9	277912.5	540	19.43
Open						Open Old GLS Group	4265866.5	6873	16.11

APPENDIX C

High-power vehicle restriction formulas for estimating change in crash rates

The number of crashes involving restricted and non-restricted vehicles and driven by drivers aged under 25 is known from available crash data. What is not known is the number that there would have been *in the absence of regulation*. These figures are key components of the counterfactual (the business-as-usual scenario that is compared with what actually happened), and are estimated below based on the estimated change in the proportion of the crash fleet for this group who were driving restricted vehicles. The formulas depend on results from a previous study that established that the risk of crash-involvement for restricted vehicles was 1.69 the risk of all other vehicles for under-25-year-olds, and that the injury rate was 2.01 (Keall and Newstead, 2011).

All calculations refer to crash-involved vehicles driven by P-plated drivers aged under 25.

$\hat{p}$ =estimated proportion of on-road fleet that are restricted vehicles after regulation

n_r =number of vehicles in crash fleet that are *restricted* vehicles after regulation

n_o =number of *other* crash-involved (non-restricted) vehicles after regulation

then $\hat{p}$ $=(n_r/1.69)/(n_o+n_r/1.69)$

$\hat{d}$ =estimated change in proportion of crash fleet that were restricted

$\hat{p}_c$ = estimated counterfactual proportion of on-road fleet that would have been restricted vehicles in the absence of regulation, with assumption that the number of vehicles on the road does not change with regulation (in other words, regulation forces drivers of high powered vehicles to drive non-high powered vehicles instead)

$=\hat{p}/(1-\hat{d})$

Risk $\text{index}_{\text{reg}}$=an index of risk of crash involvement under existing regulation

$=1.69 \times \hat{p} + (1 - \hat{p})$

Risk $\text{index}_{\text{noreg}}$=an index of risk of crash involvement under *no* regulation

$=1.69 \times \hat{p}_c + (1 - \hat{p}_c)$

Then estimated reduction in crash involvement rate

$=(\text{Risk index}_{\text{noreg}} - \text{Risk index}_{\text{noreg}})/ \text{Risk index}_{\text{noreg}}$

The change in injury rate accompanying the regulation is estimated by substituting 2.01 in the above instead of 1.69.

The results of applying these equations are shown in Table 27.

APPENDIX D

For each crash severity the following tables display the licence exposure, number of crashes and corresponding crash rates for the motorcyclists for each treatment group, comparison group, across pre-post implementation of the new GLS.

All Crashes

	Pre New GLS					Post New GLS			
Design Group	**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**		**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**
Comparison	Open	1435869	590	4.1090		Open Control	869238	251	2.8876
First Year Riders	TG2	253790.5	70	2.75818		TG1	190738	104	5.4525
	TG3	205931.5	165	8.01237					
First Year Riders						TG2	57225	23	4.0192
						TG3	38835	25	6.4375

Fatalities

	Pre New GLS					Post New GLS			
Design Group	**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**		**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**
Comparison	Open	1435869	26	0.1811		Open Control	1346121	12	0.0891
First Year Riders	TG2	253790.5	1	0.03940		TG1	366695.5	6	0.1636
	TG3	205931.5	6	0.29136					
First Year Riders						TG2	57225	3	0.5242
						TG3	38835	0	0.0000

Serious Injuries

	Pre New GLS					Post New GLS			
Design Group	**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**		**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**
Comparison	Open	1435869	272	1.8943		Open Control	1144736	165	1.4414
First Year Riders	TG2	253790.5	38	1.49730		TG1	282166	79	2.7998
	TG3	205931.5	90	4.37039					
First Year Riders						TG2	57225	11	1.9222
						TG3	38835	9	2.3175

Medically treated

	Pre New GLS					Post New GLS			
Design Group	**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**		**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**
Comparison	Open	1435869	177	1.2327		Open Control	869238	71	0.8168
First Year Riders	TG2	253790.5	17	0.66984		TG1	190738	30	1.5728
	TG3	205931.5	48	2.33087					
First Year Riders						TG2	57225	5	0.8737
						TG3	38835	9	2.3175

Minor injury

	Pre New GLS					Post New GLS			
Design Group	**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**		**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**
Comparison	Open	1435869	101	0.7034		Open Control	869238	32	0.3681
First Year Riders	TG2	253790.5	11	0.43343		TG1	190738	11	0.5767
	TG3	205931.5	20	0.97120					
First Year Riders						TG2	57225	3	0.5242
						TG3	38835	5	1.2875

Property damage

	Pre New GLS					Post New GLS			
Design Group	**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**		**Treatment Group**	**Exposure**	**Crashes**	**Crash rate**
Comparison	Open	1435869	14	0.0975		Open Control	869238	3	0.0345
First Year Riders	TG2	253790.5	3	0.11821		TG1	190738	2	0.1049
	TG3	205931.5	1	0.04856					
First Year Riders						TG2	57225	1	0.1747
						TG3	38835	2	0.5150