Overtaking Cyclists’ Road Safety Study
Minimum Overtaking Distance

By

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Abstract

Bicycle riding is increasingly popular, while actions to improve a safe cycling environment is lacking. ‘Perceived danger of cycling’ is one of the dominant barriers to cycling; in order for a safer cycling environment has to be developed. The most common cyclist fatality crash type is to be hit from behind by a motor vehicle travelling in the same direction. Queensland started to commence a two-year trial of minimum overtaking distance legislation since 7th April 2014. Along with other counties’ ‘Minimum Overtaking Distance’ law implementation, it is believed that this act can effectively improve cyclists’ road safety. However, there is no apparent prove that the ‘Minimum Overtaking Distance’ will help improve cyclists’ road safety. The objective of this paper is to determine whether a car’s lateral overtaking distance when passing bicycles will help improve cyclists’ road safety, and to understand drivers’ and cyclists’ perspectives towards the ‘Minimum Overtaking Distance’. It was hypothesized that the ‘Minimum Overtaking Distance’ will help improve cyclists’ road safety.

This research was primarily based on a survey targeting at drivers and cyclists in New South Wales. The survey helped understand drivers’ and cyclists’ perspectives towards the ‘Minimum Overtaking Distance’. The second stage of this study was a driving simulation, which was programmed according to a typical Sydney suburban driving scenario. The simulation started with a 10 minutes warm up drive, followed with an action which a bicycle overtakes the subject. Statistics of the participant’s behaviour such as reaction times, driving speed and lateral overtaking distance were recorded.

In most situations, majority of the drivers tend to slow down and overtake cyclists when safe. 99% of the cyclists think that a sufficient overtaking distance is important to them, while only 15% of the drivers have a good control over their passing distance. In order to improve the existing overtaking risk experienced by
cyclists, 75% of the road users believe that a specified ‘Minimum Overtaking Distance’ should be legalized, whilst 60% think that 1 metre is the most suitable distance. It is shown that the ability to control a ‘Specified Overtaking Distance’ would not be a concern for at least 85% of drivers. It can be concluded that a specified ‘Minimum Overtaking Distance’ can help improve safety of cyclists’ on road. It can effectively improve subjective sense of safety for both existing cyclists and non-cyclists.
Acknowledgement

Immeasurable appreciation and gratitude for the help and support are extended to the following persons and groups who in one way or another have contributed in making this study possible.

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**Bicycle NSW.** for their generous support by providing two Bicycle NSW memberships, this has encouraged a large amount of participants to take part in the survey. And last by posting my survey on their social media platform and E-News.

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To **J.Y. Chan, Toni Leung, Toby Tang, Yves Lee** and my family for the continual support throughout my University studies.

I would like to thank all the participants for taking the time to complete the survey. This research project would not have been possible without their input.
Originality Statement

‘I hereby declare that this submission is my own work and to the best of my knowledge it contains no materials previously published or written by another person, or substantial proportions of material which have been accepted for the award of any other degree or diploma at UNSW or any other educational institution, except where due acknowledgement is made in the thesis. Any contribution made to the research by others, with whom I have worked at UNSW or elsewhere, is explicitly acknowledged in the thesis. I also declare that the intellectual content of this thesis is the product of my own work, except to the extent that assistance from others in the project's design and conception or in style, presentation and linguistic expression is acknowledged.’

Signed ........................................................................................................................................

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1. Introduction

1.1 Background

This research project was originally initiated from the perspective that there is a need for a safer cycling environment. Based upon a research conducted by AMR interactive that explored the barriers of cycling amongst non-cyclists and infrequent cyclists. “The perceived danger of cycling, and commuter cycling in particular, due to perceived or actual lack of safe places to cycle, and the fear of being hit by a motorist” is one of the dominant barriers that were identified. (Span, 2009)

Various approaches were proposed in order to develop a safer cycling environment for the community, while one of the most debatable proposition is to legalize a ‘Minimum Overtaking Distance’. The most common cyclist fatality crash type is being hit from behind by a motor vehicle that was traveling in the same direction; this is commonly caused by driver’s inability to provide a safe lateral overtaking distance. In these crashes, the cyclists have minimal ability to protect themselves, and are unable to take any evasive action to avoid the crash. It is believed that this type of fatality crash can be avoided if a driver remains a safe overtaking distance when passing bicycles, and that it is a driver’s responsibility to do so. (Amy Gillett Foundation, 2013)

It is inevitable that there is a dramatic number of bicycle related crashes in Australia, 35 fatalities and over 9,500 serious injuries on average every year. The existing guidelines and road rules in Australia are unable to fully protect cyclists on road; The Amy Gillett Foundation (AGF) have been working on amending the road rules across Australia and to introduce a specified ‘Minimum Overtaking Distance’ when drivers pass bicycle riders. It can be seen that there are flaws in the existing road rules and guidelines. However, there is a need to investigate the effectiveness of a specified ‘Minimum Overtaking Distance’ in improving
cyclists’ road safety, as well as taking into account of drivers’ and cyclists’ perspectives towards this act.

1.2 Problem Statement

Bicycle riding is increasingly popular, while actions to improve a safe cycling environment is lacking. The number of cyclists in Australia is up to 4 million in 2011 and it's the Australian government’s target to double this population in 2016. ‘Perceived danger of cycling’ is one of the dominant barriers to cycling; a safer cycling environment has to be developed in order for the cycling population to increase. As the cycling population rises, it is vital to understand the causes of accidents, in order to reduce the accidental rates. The most common cyclist fatality crash type is to be hit from behind by a motor vehicle that was traveling in the same direction. Although it is the driver’s responsibility to allow a safe overtaking distance when passing cyclists, however, the instruction is unclear and inadequate to effectively protect cyclists on the road. Laws have been implemented in 23 states in the United States, requiring drivers to leave a minimum of 3 feet (0.91m) lateral distance when overtaking bicycle riders. In addition to the US, countries that confirmed with the overtaking distance law include Belgium (1m), France (1m in towns, 1.5m out of towns) and Portugal (1.5m). (Amy Gillett Foundation, 2013)

Queensland has started to commence a two-year trial of minimum overtaking distance legislation since 7th April 2014. Along with other counties’ ‘Minimum Overtaking Distance’ law implementation, it is believed that this act can effectively improve cyclists’ road safety. However, there is no apparent prove that the ‘Minimum Overtaking Distance” will help improve cyclists’ road safety. The objective of this paper is to determine whether the ‘Minimum Overtaking Distance’ will help improve cyclists’ road safety. This prompts the questions whether it is reasonable to legalize a specified minimum overtaking distance when drivers pass cyclists. Furthermore, it is to understand drivers and cyclists’
perception towards this act, which will hopefully help increase awareness. Thus, decreases the cycling accident rates that was caused by overtaking cyclists.

1.3 Research Objectives

A few areas are required to be explored in order to come to a fundamental conclusion for this problem. The objectives of this research were to:

- Identify the factors that restricts drivers to allow a specified minimum overtaking distance;
- Identify effectiveness of the existing overtaking guidelines.
- Identify current perception of cyclists and drivers towards the legalization of a specified ‘Minimum Overtaking Distance’;
- Identify current perception of cyclists and drivers towards the need to develop a safer cycling environment;
- Explore the differing perspectives towards cyclists’ road safety between drivers who cycles and do not cycles;
- Explore the most effective initiatives to facilitate drivers when overtaking cyclists.
2. Literature Review

2.1 Introduction

Related literatures were reviewed as the study begins in order to find documented answers to the research questions. Also to develop a safe cycling environment through identifying current strategies.

The literature review looks at the current cycling environment in Australia, and propose national cycling strategies for the future. Research of the statistics and nature of cyclist casualty and fatality rates will identify whether the proposed strategies are relevant to the improvement of existing cycling environment. The final section looks at ‘Minimum Overtaking Distance' within the international and Australia context.

The literature review has acted as a valuable tool to guide this research, with a particular focus on the overtaking distance when motorists pass cyclists. It also addresses the existing solutions in foreign countries and the potential opportunities in Australia.
2.2 Cycling in Australia

In 2011, there are up to 4 million cyclists in Australia and is foreseeing an increase number in the future. The Australian government is aware of the advantage of cycling and it is the national target to double the cyclist population by 2016. (Austroads Ltd, 2010)

In Australia, cycling as a form of transportation to full-time work or study is still at a low level. The population that uses bicycle as a mode of transport to get to full-time work or study has increased from 1.1% in 2000 to 1.5% in 2009 (Figure 1). However male are three times more like to cycle than female, demonstrating a significant cycling population disparity between genders. Research indicates that Australians do not walk or cycle to full-time work or study due to one of the three major reasons as ‘It’s not safe’ (Figure 2). (ABS, 2009)

In terms of road safety, there is an approximate 3% reduction in cyclist road deaths between 2004 and 2009. There have been several campaigns to promote cyclist road safety, this includes ‘Share the Road’ in many jurisdictions, the ‘A Metre Matters’ and the ‘Safe riding: A guide to safe cycling’ by the NSW RTA. (Austroads Ltd, 2010)

Figure 4. Cycling as a main form of transport used on usual trip to work or full time study, 2000 to 2009.

Figure 5. Reasons Australians do not walk or cycle to full time work or study.
Without additional rules, cyclists in NSW have the same rights and responsibilities as other road users, while not having other additional rules. Sydney has a range of bike paths, including shared cycle and pedestrian paths, on road paths, and a small amount of separated cycleways. The City of Sydney has created a Bicycle Action Plan 2007-2017, to increase the total percentage trips and to build more cycleways.

The Australian Bicycle Council has published the Australian National Cycling Strategy 2011-2016, underpinning six key objectives to encourage the general public to cycle. These strategies include:

- **Cycling promotion**: to promote cycling as both a viable safe mode of transport and enjoyable recreational activity.
- **Infrastructure and facilities**: to create a comprehensive and continuous network of safe and attractive routes to cycling and end-of-trip facilities.
- **Integrated planning**: consider and address cycling needs in all relevant transport and land use planning activities.
- **Safety**: Enable people to cycle safely
- **Monitoring and evaluation**: Improve monitoring and evaluation of cycling programs and develop national decision-marking process for investment in cycling.
- **Guidance and best practice**: development of nationally consistent guidance for stakeholders to use and share best practice across jurisdiction.

(Austroads Ltd, 2010)

With most strategies aiming to increase the cyclist population, it can be seen that Australia is aware of the benefit of cycling in the proposal. However, there is a lack of specific focus on cyclists' on road safety in the proposed strategies and objectives. In the next section, obstacles to cycling are explored in order to understand the factors that are preventing a greater cycling population in Australia.
2.3 Barriers to Cycling in NSW

Literature that explored the barriers to cycling were studied in order to understand the factors that are preventing the cycling participation in Australia. A research from the University of Rutgers evidenced that the fear of being hit from behind by a motorist is a key reason to travellers not cycling on the road. It was commented that if there is a greater sense of subjective safety, the number of cyclists is likely to increase.

“One advocate noted that being hit by a motorist from behind is far from the top cause of bicycle accidents, yet it is one of the top fears of non-cyclists. Therefore, one of the primary benefits of the 3 Foot Law is to make non-cyclists feel more comfortable getting on a bike. This in itself yields safety benefits, as the best way to decrease risk is to increase the number of people bicycling. Greater numbers of cyclists makes motorists more likely to expect their presence and become accustomed to sharing the road.” (Alan M. Voorhees, 2011)

A report *Cycling: Getting Australia Moving* by Cycling Promotion Fund identified the barriers that prevent cycling population to increase in Australia (*Table 1*). Safety was identified as the most significant factor that is preventing the general public from cycling. (*Infrastructure Australia, 2009*)

<table>
<thead>
<tr>
<th>Barriers preventing greater cycling participation in Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor</strong></td>
</tr>
<tr>
<td><strong>Safety</strong></td>
</tr>
</tbody>
</table>

*Table 4. Barriers preventing greater cycling participation in Australia*
Research into Barriers to Cycling in NSW conducted by AMR interactive identified barriers that are preventing regular cycling. Four dominant barriers were found, one of which is the “perceived danger of cycling, and commuter cycling in particular, due to perceived or actual lack of safe places to cycle, and the fear of being hit by a motorist.” (AMR interactive, 2009)

“Non-cyclists expressed a very real fear that they would be hit or run over by car-drivers if they cycled on roads.” (AMR interactive, 2009)

This demonstrates that the general public is not confident with the existing road rules and guidelines to protect them when cycling on road.

“You’re talking about variable weather conditions; you’re talking about traffic; if you’re going to an environment where you don’t know it very well, putting all those things together you need to be confident in terms of the bike itself and know the bike.” (Sydney, AMR interactive, 2009)

Non-cyclists believe that they need to be a very confident cyclist before commuting on road, while the existing on road cycling environment fails to provide them with such confidence. It can be seen from Table 2 and Table 3, that safety is the most significant reason for not cycling. Thus, a need to develop a safer on road cycling environment to protect cyclists is inevitable to encourage cycling as a form of transportation. In order to improve cycling safety, statistical data of cyclist injuries and fatalities are explored in the next section to further understand the nature of accidents.
<table>
<thead>
<tr>
<th>REASON</th>
<th>Total (n=235)</th>
<th>Area</th>
<th>Gender</th>
<th>Age group</th>
</tr>
</thead>
</table>
|                                             | % (n=235)     | Sydney (n=144) | Regional (n=91) | Male (n=108) | Female (n=127) | 18-39 (n=88) | 40-59 (n=102) |%
| Safety Reasons/Roads too dangerous         | 18            | 22   | 16     | 13        | 20             | 19          | 31          |
| Lack of places to cycle                     | 4             | 5    | 2      | 4         | 5              | 5           | 4           |
| Traffic                                     | 3             | 4    | 2      | 2         | 4              | 0           | 6           |
| Drivers not educated in safety for cyclists/Unaware of cyclists | 0             | 1    | 0      | 1         | 0              | 0           | 1           |
| Other safety issues                         | 1             | 2    | 0      | 1         | 1              | 1           | 0           |
| Safety issues                               | 26            | 34   | 16     | 24        | 30             | 19          | 31          |
| Medical reasons/Physically unable to ride   | 18            | 13   | 24     | 17        | 18             | 3           | 21          |
| Prefer/Do alternative fitness activities    | 6             | 4    | 8      | 7         | 5              | 2           | 8           |
| Too hard/Laziness                           | 3             | 4    | 1      | 3         | 4              | 7           | 2           |
| Never learnt/Can't ride/Would fall          | 7             | 10   | 2      | 0         | 12             | 4           | 9           |
| Toxic fumes                                 | 1             | 1    | 0      | 0         | 1              | 0           | 0           |
| Other health/activity                        | 1             | 1    | 0      | 0         | 2              | 0           | 2           |
| Health/Ability to ride issues               | 36            | 33   | 35     | 27        | 42             | 16          | 42          |
| Time constraints/Lack of time               | 19            | 22   | 16     | 25        | 15             | 28          | 17          |
| Hours of work                               | 2             | 3    | 1      | 3         | 2              | 2           | 3           |
| Time issues                                 | 22            | 25   | 17     | 28        | 16             | 30          | 20          |
| Not interested                              | 11            | 12   | 9      | 12        | 11             | 14          | 10          |
| Family considerations                       | 5             | 6    | 5      | 1         | 10             | 11          | 3           |
| Happy with degree of fitness               | 2             | 2    | 3      | 4         | 1              | 1           | 3           |
| Other general interest                      | 3             | 4    | 2      | 3         | 4              | 3           | 5           |
| Interest issues                             | 21            | 24   | 19     | 20        | 26             | 25          | 23          |
| Geographically unsuited to where I live     | 9             | 2    | 21     | 4         | 14             | 6           | 10          |
| Clothing issues                             | 0             | 0    | 0      | 1         | 0              | 1           | 0           |
| Weather issues                              | 0             | 1    | 0      | 0         | 1              | 1           | 0           |
| Other inconvenience                         | 2             | 1    | 5      | 2         | 3              | 3           | 2           |
| Feasibility/Convenience                     | 12            | 3    | 26     | 6         | 17             | 11          | 12          |
| Too expensive to buy/Good bike too expensive| 7             | 7    | 8      | 9         | 5              | 14          | 2           |
| Parking considerations/Nowhere to secure bike| 1             | 1    | 0      | 1         | 1              | 1           | 0           |
| Other logistics issues                      | 1             | 2    | 0      | 2         | 1              | 2           | 1           |
| Logistics                                   | 9             | 10   | 8      | 12        | 7              | 17          | 3           |
| Prefer public transport/Driving             | 1             | 1    | 0      | 1         | 0              | 0           | 1           |
| Vehicle use necessary                       | 1             | 0    | 2      | 2         | 0              | 0           | 1           |
| Other transport preference                  | 1             | 1    | 0      | 0         | 1              | 1           | 1           |
| Transport related                           | 3             | 2    | 2      | 3         | 1              | 2           | 2           |

Statistically significant difference between groups (p<.05) on the overall categories of reasons (bolded), highlighting **higher and ***lower results

Table 5. Reasons for not cycling for recreation/exercise, by area, gender and age
<table>
<thead>
<tr>
<th>REASON</th>
<th>Total (n=69) %</th>
<th>Area Sydney (n=67) %</th>
<th>Regional (n=32) %</th>
<th>Gender Male (n=50) %</th>
<th>Gender Female (n=49) %</th>
<th>Age group 18-39 (n=41) %</th>
<th>Age group 40-59 (n=43) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Reasons/Roads too Dangerous</td>
<td>23</td>
<td>29</td>
<td>10</td>
<td>18</td>
<td>28</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>Lack of places to cycle (paths, etc.)</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Traffic</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Safety issues</td>
<td>28</td>
<td>37</td>
<td>10</td>
<td>29</td>
<td>28</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>Geographically unsuited to where I live</td>
<td>14</td>
<td>15</td>
<td>12</td>
<td>9</td>
<td>19</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Weather issues</td>
<td>6</td>
<td>3</td>
<td>11</td>
<td>8</td>
<td>3</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Arrive sweaty/no showers at work</td>
<td>6</td>
<td>9</td>
<td>0</td>
<td>6</td>
<td>7</td>
<td>11</td>
<td>3</td>
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<tr>
<td>Clothing issues</td>
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<td>8</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>5</td>
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<tr>
<td>Other inconvenience</td>
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<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Feasibility/Convenience</td>
<td>32</td>
<td>31</td>
<td>31</td>
<td>24</td>
<td>39</td>
<td>39</td>
<td>25</td>
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<tr>
<td>Too expensive to buy/ Good bike too expensive</td>
<td>7</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Parking considerations/ Nowhere secure for bike</td>
<td>6</td>
<td>9</td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Costs to take bike on train</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Other logistics issues</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>0</td>
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<tr>
<td>Logistics</td>
<td>19</td>
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<td>6</td>
<td>13</td>
<td>24</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Medical Reasons/Age/Physically unable to ride</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Too hard/Laziness</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Prefer alternative fitness activities</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Happy with my degree of fitness</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Never learnt to ride a bike/Can’t ride</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Toxic fumes</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other health/activity</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Health/activity/ability to ride</td>
<td>16</td>
<td>14</td>
<td>20</td>
<td>18</td>
<td>13</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Time constraints/Lack of time</td>
<td>5</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Hours of work</td>
<td>10</td>
<td>11</td>
<td>8</td>
<td>5</td>
<td>14</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Time</td>
<td>15</td>
<td>18</td>
<td>8</td>
<td>12</td>
<td>17</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Prefer Public Transport/Driving</td>
<td>12</td>
<td>6</td>
<td>25</td>
<td>14</td>
<td>10</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Vehicle necessary for work purposes</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Other transport preference</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Transport preference</td>
<td>15</td>
<td>8</td>
<td>33</td>
<td>18</td>
<td>14</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Not interested</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Family commitments</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Other interest issues</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Interest</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>8</td>
<td>2</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

*Indicative trends between groups on the overall categories of reasons (bolded), showing higher results*

Table 6. Reasons for not cycling for commuting among those who live within 10km of work/train/ferry
2.4 Accident, Injury & Fatality Statistics in Australia

The ATSB has published a Road Safety Report on Deaths of cyclists due to road crashed, it was reported that the total cyclist deaths in road crashes range from 26 to 46 per year. Males accounted for over 80 percent of total cyclist deaths in road crashes, particularly in age groups 10-14 years, 15-19 years and 70 years or over (Figure 3, Table 4). (ATSB, 2006)

Figure 3. Cyclists killed in road crashes, Australia, 1989 to 2005: deaths in each calendar year

Table 4. Cyclists killed in road crashes, Australia, 1991 to 2005: age groups by gender and period
It is observed that approximately 86% of cyclist deaths were resulted from a collision between bicycle and a motor vehicle \((\text{Figure 4}). (\text{ATSB. 2006})\)

<table>
<thead>
<tr>
<th>Event</th>
<th>Counterpart</th>
<th>Percentage of cyclist deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collision with</td>
<td>pedestrian</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pedal cycle or other non-motor vehicle</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>car, pick-up truck, van or other motor vehicle</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>heavy transport vehicle</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>railway train or railway vehicle</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>fixed or stationary object</td>
<td>4</td>
</tr>
<tr>
<td>Not a collision</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Table 5. Cyclists killed in road crashes, Australia, 1997-2004: circumstances of death

Between 1996-2000 222 cyclists were killed, while most deaths were resulted from crashes involving a motor vehicle. The most common type of motor vehicles involved in these crashes were cars (40%) followed by trucks (33%). The main types of crashes displayed in Table 6, showing that 21% of the motor vehicle ran into the rear of a bicycle travelling in the same lane in the same direction causing a crash, as the most significant crash time in causing death in road cyclists. Thus, this literature review supports the motif of this study to investigate the effectiveness of a ‘Minimum Overtaking Distance’, which is believe to have the ability to eliminate this crash type. \((\text{ATSB, 2006})\)

<table>
<thead>
<tr>
<th>Crash event</th>
<th>Day</th>
<th>Night</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban / Rural</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>15</td>
<td>5</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>Night</td>
<td>4</td>
<td>2</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>6</td>
<td>34</td>
<td>51</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>15</td>
<td>5</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Night</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>7</td>
<td>21</td>
<td>48</td>
</tr>
</tbody>
</table>

Table 6. Crashes in which a cyclist was killed, Australia, 1996 to 2000: crash type by location (urban or rural) and time (day or night)
A paper published by the Journal of the Australasian College of Road Safety on *Cycling injuries in Australia: Road safety’s blind spot?*, commented on the vulnerability of cyclists on roads. “The traffic-related fatality and serious injury rates for cyclists in this study are high in comparison with many other wealthy countries.” Table 10 and table 11 shows that bicycle riders have a relatively higher fatality and injury risk than car occupants. In Sydney, the fatality and injury risk of a cyclist is 10 to 20 times higher than car occupant. The Australia’s existing regulations and infrastructure fails to protect cyclists as much as car occupants, however, some of the existing factors to improve motor vehicle occupant’s safety might increase the risk to vulnerable road users. “The large difference in cycling safety between Australia and many other wealthy nations, as well as the large and increasing gap between cyclist and car occupant safety in Australia, suggest that there may be a ‘cycling blind spot’ in road safety in Australia.” This literature review correlates with the objective of this study, that there is a need to develop a safer on road cycling environment in Australia. (J Garrard et.al., 2010)

<table>
<thead>
<tr>
<th>Year</th>
<th>Fatality count</th>
<th>Average daily distance travelled (5-yr pooled)</th>
<th>Fatality rate (per 10^6km)</th>
<th>Relative risk (Bicycle: car)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Car occupant</td>
<td>Bicycle</td>
<td>Car occupant</td>
<td>Bicycle</td>
</tr>
<tr>
<td>2002</td>
<td>185</td>
<td>10</td>
<td>121,983,414</td>
<td>487,687</td>
</tr>
<tr>
<td>2003</td>
<td>164</td>
<td>9</td>
<td>122,087,060</td>
<td>360,147</td>
</tr>
<tr>
<td>2004</td>
<td>165</td>
<td>8</td>
<td>130,962,527</td>
<td>452,459</td>
</tr>
<tr>
<td>2005</td>
<td>168</td>
<td>9</td>
<td>130,262,321</td>
<td>630,420</td>
</tr>
</tbody>
</table>

Table 7. Fatality risk for cyclists and car occupants in Sydney GMA (2002-2005)

<table>
<thead>
<tr>
<th>Year</th>
<th>Injury count</th>
<th>Average daily distance travelled (5-yr pooled)</th>
<th>Fatality rate (per 10^6km)</th>
<th>Relative risk (Bicycle: car)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Car occupant</td>
<td>Bicycle</td>
<td>Car occupant</td>
<td>Bicycle</td>
</tr>
<tr>
<td>2002</td>
<td>16,526</td>
<td>1,014</td>
<td>121,983,414</td>
<td>487,687</td>
</tr>
<tr>
<td>2003</td>
<td>15,983</td>
<td>901</td>
<td>122,087,060</td>
<td>360,147</td>
</tr>
<tr>
<td>2004</td>
<td>15,222</td>
<td>928</td>
<td>130,962,527</td>
<td>452,459</td>
</tr>
<tr>
<td>2005</td>
<td>14,860</td>
<td>948</td>
<td>130,262,321</td>
<td>630,420</td>
</tr>
</tbody>
</table>

Table 8. Injury risk for car occupant and cyclists in Sydney GMA (2002-2005)
This section of the literature review has a significant contribution to this study. From earlier reviews, it was understood that safety is the key barrier to cycling; this section of the literature review shows the nature of accidents and particular focus groups that have a higher injury and fatality risk. This prompts the purpose of this study. It is vital to understand the importance of ‘Minimum Overtaking Distance’ as with cyclists being hit from behind by a car travelling in the same direction remains to be the accident with highest fatality risk. The effectiveness of a specified ‘Minimum Overtaking Distance’ to improve cyclists’ on road safety, as well as drivers and cyclists’ perspective towards this act has to be explored.

2.5 Minimum Overtaking Distance

The literature reviewed in previous sections indicates the need to develop a safer cycling environment, due to cyclists behind hit from behind by a motorist travelling in the same direction being the most common fatality crash type. The most prominent strategy is by establishing a specified ‘Minimum Overtaking Distance’ to minimize the occurrence of this crash type. In this section, it will look at the existing road rules and overtaking guidelines, along with the ‘Minimum Overtaking Distance’ precedent from both the International and Australian context. A ‘Minimum Overtaking Distance’ is referred to as the minimum lateral overtaking distance when a car is passing a bicycle (Figure 4, Figure 5).
As a result of legalizing a specified ‘Minimum Overtaking Distance’, a message would be promoted from a research on ‘Minimum Overtaking Distance’ by Amy Gillett Foundation. “A minimum overtaking distance of one metre provides absolute and practical clarity as it:

• will improve safety for bicycle riders
• will provide the definition of a specified distance
• recognizes bicycle riders as legitimate road users that are more vulnerable than other road users
• recognizes that bicycle riders need the protection of space when sharing roads with drivers
• provides drivers with a clear, easily recognized measure when overtaking bicycle riders- otherwise drivers must slow down and wait
• reduces the risk of bicycle rider-driver crashes, and bicycle rider crashes resulting from being side-swiped (but not hit) by motor vehicles
• is enforceable; it allows a law enforcement officer/ witness to readily evaluate driver’s actions
• will maintain efficiency for all road users across the road transport system
• will include greater separation for higher speed zones (1.5m in speed zones over 60km/h)
• provides bicycle riders with space to avoid obstacles
• will ultimately reduce bicycle rider fatalities and series injuries”

(Amy Gillett Foundation, 2013)

Although not all of the listed benefits by Amy Gillett Foundation are proved to be effective, however, it can be seen that the ‘Minimum Overtaking Distance’ is believed to be an effective approach in improving cyclist safety. There is a need to provide statistical evidence in support to the benefits stated above, survey questions were generated from the literature review in order to answer some of the arguments accordingly.
Laws have not been implemented in most states and territories in Australia have recommended drivers to leave at least one metre when overtaking a cyclist. Australian Road Rule (ARR) 144 is the main road rule that relates to overtaking cyclist’s behavior.

144  **Keep a safe distance when overtaking**
A driver overtaking a vehicle:

(a) must pass the vehicle at a sufficient distance to avoid a collision with the vehicle or obstructing the path of the vehicle; and

(b) must not return to the marked lane or line traffic where the vehicle is travelling until the driver is a sufficient distance past the vehicle to avoid a collision with the vehicle or obstructing the path of the vehicle.

*(National Road Transport Commission, 2012)*

It has been argued that the stated ‘sufficient distance’ in this ARR 144 does not provide a clear measurement for drivers. *Amy Gillett Foundation* believe the Australian Road Rule should specify a minimum overtaking distance of one meter at all times. Precedents of ‘Minimum Overtaking Distance’ in an International context are studied to interpret whether this recommendation is adequate to the problem.

2.5.1 **International Context**

Similar to Australia, the United States of America does not have a bicycle-inclusive approach for cyclists. 23 states in the United States have implemented laws that require drivers to remain a minimum of 3-feet (0.91m) when overtaking cyclists *(Figure 6).* *(Amy Gillett Foundation, 2013)*
Most countries in Europe have been successful in developing a transportation system that is balanced and safe between motor vehicles, public transportations, bicycles and pedestrians. Education is another important factor that provides a safer cycling environment in many European countries, in turns it have led to a higher rate of cycling. The following counties have been confirmed with Minimum Overtaking Distance Law (Amy Gillett Foundation, 2013):

- Belgium (1m)
- France (1m in towns, 1.5m out of towns)
- Portugal (1.5m)
- Nova Scotia, Canada (1m)

Details of the laws as below: (translated by Amy Gillett Foundation, 2013)
Belgium
Current road rule: The Highway Code, Article 40ter

The driver of a car or a motorcycle must have a lateral distance of at least one meter to between his vehicle and the rider (cyclist) or driver of a two-wheeled moped.

France
Current road rule: Article R414-4, Code de la Route

To overtaking they should deport enough to not risk hitting the user that wants to overtake. It should not in any case be approached laterally within 1 meter in urban areas and 1.50 m out of town if it is an animal-drawn vehicle, a vehicle with two or three wheels, a pedestrian, a jumper or animal

Portugal
Current road rule: Article 38 of the Highway Code

The driver of a vehicle overtaking should not start without making sure that they can perform without danger of colliding with vehicle transiting in the same direction or in the opposite direction.

The driver should especially make sure that in overtaking bicycles or pedestrian crossing or traversing find the side, keeps the minimum lateral distance of 1.5 meters and slows the speed.

It is evident that the level of education, infrastructure and legislations in Australia falls behind the existing global cycling environment. To understand the current status overtaking cyclists’ road safety, overtaking guidelines and legislations in Australia were studied.
2.5.2 Australia Context

Overtaking guidelines are available within most of states and territories in Australia, as it is not legalized, most drivers are not aware of the recommendation (*Table 9, Amy Gillett Foundation, 2013*).

<table>
<thead>
<tr>
<th>State</th>
<th>Link</th>
<th>Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td><a href="http://www.rta.nsw.gov.au/roadsafety/bicycles/index.html">http://www.rta.nsw.gov.au/roadsafety/bicycles/index.html</a></td>
<td>Motorists are encouraged to allow at least a one-metre gap when they overtake a cyclist</td>
</tr>
<tr>
<td>Northern Territory</td>
<td><a href="http://www.transport.nt.gov.au/__data/assets/pdf_file/0006/19923/section3.pdf">http://www.transport.nt.gov.au/__data/assets/pdf_file/0006/19923/section3.pdf</a></td>
<td>When you overtake you must: give at least 1 metre clearance when overtaking a bicycle. If this clearance is not possible do not overtake until it is safe to do so. After overtaking, make sure you are well clear of the bicycle before moving back.</td>
</tr>
<tr>
<td>Queensland</td>
<td><a href="http://www.qld.gov.au/transport/safety/rules/other/cyclists/index.html">http://www.qld.gov.au/transport/safety/rules/other/cyclists/index.html</a></td>
<td>Motorists must stay wider of cyclists by giving a minimum of: 1m when passing a cyclist in a 60km/h or less speed zone or 1.5m where the speed limit is over 60km/h</td>
</tr>
<tr>
<td>South Australia</td>
<td><a href="http://www.dpti.sa.gov.au/roadsafety/safe_road_users/cyclists">http://www.dpti.sa.gov.au/roadsafety/safe_road_users/cyclists</a></td>
<td>Give cyclists plenty of room; a minimum of 1m clearance when overtaking.</td>
</tr>
<tr>
<td>Tasmania</td>
<td><a href="http://www.cyclingsouth.org/images/stories/Documents/str-final.pdf">http://www.cyclingsouth.org/images/stories/Documents/str-final.pdf</a></td>
<td>Leave space when overtaking. When passing bicycle riders, either riding single file or two abreast, give at least one metre clearance in urban areas and two metres clearance on the open road.</td>
</tr>
<tr>
<td>Victoria</td>
<td><a href="http://www.vicroads.vic.gov.au/Home/SafetyAndRules/SaferRiders/BikeRiders/SharingTheRoad.htm">http://www.vicroads.vic.gov.au/Home/SafetyAndRules/SaferRiders/BikeRiders/SharingTheRoad.htm</a></td>
<td>Be patient and give bike riders a clearance of at least one metre when passing them, more if travelling over 60km/h.</td>
</tr>
<tr>
<td>Western Australia</td>
<td><a href="http://www.ors.wa.gov.au/Demographic-Pages/I-Am-A-Driver/Sharing-the-Road">http://www.ors.wa.gov.au/Demographic-Pages/I-Am-A-Driver/Sharing-the-Road</a></td>
<td>As a driver, you should share the road with cyclists and be aware of their movements at all times. Cyclists may need to ride slightly away from the kerb or gutter at times due to debris and other hazards. They should be given at least one metre of space when being overtaken. Remember that bicycles are regarded as a vehicle, so cyclists have the same rights as a motor vehicle driver.</td>
</tr>
</tbody>
</table>

*Table 9. Overtaking guidelines and legislation in each state and territory in Australia (October, 2014)*
South Australia Government has committed to implement Safe Passing Distance Law on the 22nd of January 2015, becoming the third jurisdiction to commit to legislating a minimum overtaking distance of one metre for drivers overtaking bike riders. Australia Capitol Territory (ACT) accounted to the trial of minimum overtaking distance legislation in September 2014, requiring drivers to leave one metre when passing in speed zones of up to 60km/h and 1.5 metres in speed zones faster than 60km/h. However, affective date and duration for the trial in ACT have not yet been finalized. *(Amy Gillett Foundation, 2015)*

Queensland started to commence a two-year trial of minimum overtaking distance legislation since 7th April 2014. The Queensland Minister for Transport Scott Emerson announced a two-year trial of a minimum passing distance for motorists who are overtaking cyclists: one metre on roads with speed limits up to 60km/h and 1.5m on faster roads. *(Queensland Transport & Motoring, 2015)*

It can be seen that Australia has had significant progress on the legalization of ‘Minimum Overtaking Distance’. This literature review has directed this study to focus on the current situation in NSW, the survey of this study targets drivers and/ or cyclists in NSW. The literature review for this study has effectively shown that an improved cycling environment is in need, especially on the focus of safety. Hopefully, this study will hopefully help to find whether a specified ‘Minimum Overtaking Distance’ is an effective way to improve cyclists’ on road safety, as well as to further understand drivers and cyclists’ perspectives towards in this act. Although this study is unable to show whether a specified ‘Minimum Overtaking Distance’ can decrease injury and fatality rates, but it can proof whether can be effectively induced a greater sense of subjective safety for cyclists and non-cyclists. Also, to improve cyclist’s road safety in order to create a safer cycling environment.
3. Research Methodology

The methodologies presented in this paper have been used to determine the effectiveness of ‘Minimum Overtaking Distance’ in improving the existing cycling environment. This study is primarily based on an Overtaking Cyclists’ Road Safety Survey, in order to understand the perspectives of drivers and cyclists’ towards the ‘Minimum Overtaking Distance’, as well as different attitudes between drivers who cycles and do not cycle. This study is commissioned to create a driving simulation, to explore the newly established UNSW iCITI TRACSlab by programming a virtual overtaking situation. In order develop a foundation for further studies in this area, the creation of this driving simulation is to focus on the programming process. This section describes the experimental procedures involved in the Overtaking Cyclists’ Road Safety Survey and the Driving Simulation.

The survey and driving simulation experiments were approved by the UNSW Human Research Ethics Advisory Panel (HREA) prior to distribution.

3.1 Overtaking Cyclists’ Road Safety Survey

Data survey collection was considered to be the best research method to understand drivers and/ or cyclists’ perspectives towards the ‘Minimum Overtaking Distance’ and the existing cycling environment in NSW. An online published survey would allow a large amount of data to be collected feasibly. Hence, survey data collection was adopted in this research. This section will describes the survey content, design and sampling method.

3.1.1 Survey Design and Administration

The preferred survey method was a web-based survey program (KeySurvey Software) was chosen, this can minimize the distribution time and cost of the surveys to participants.
In order to analyze the different perspectives between drivers who cycles, drivers who do not cycle and cyclist only, the survey was separated into three main areas.

To ensure that the survey does not question excess information and irrelevant data, the literature reviewed has directed the scope of the survey. The questions involved in the survey was written according to the targeted survey sample, that was generated by the existing questions that helps answer the objectives of this study. As a result, the survey was designed to obtain data limited by the following information:

- Information of the participants (Age, Gender, experience etc.)
- Nature of the participants (Driver only, Cyclist only, Driver and Cyclist)
- Perspective towards the ‘Minimum Overtaking Distance’
- Perspective towards the existing on road cycling environment

Using the collected data above, the perspectives between the different focus groups towards the ‘Minimum Overtaking Distance’ can be analyzed. It can also provide an understanding of whether the ‘Minimum Overtaking Distance’ will be effective in improving cyclists’ on road safety in NSW.

3.1.2 Survey Data Collection

The online survey was distributed via various platforms. A link to the survey was emailed to students and staffs of the UNSW Engineering Faculties. The survey was accessible online for one month, from the 15th of December 2014 to the 15th of January 2015. The survey link was also posted by a number of Bicycle Organizations on their social media platform and Community Newsletter, including Bicycle NSW, Safe Cycling Australia and Amy Gillett Foundation. In order to increase response rates, an incentive to win one of eight MyBus1 Concession Travel 10 Passes and one of two Bicycle NSW memberships were offered.
3.1.3 Survey Sampling and Data Filtering

A sampling frame is a database from which the sample is selected. Due to time constraints, and the varied road rules and regulations throughout Australia, this study was decided to focus on New South Wales as its sampling frame. The sample frame was the drivers and/or cyclists in New South Wales, thus excluding individuals who do not drive or cycle.

Screener questions were used to identify target respondents for the survey. As the study was interested in drivers and/or cyclists in New South Wales, the only qualifiers are of a practical nature:

- Must be a cyclist and/or a driver in New South Wales
- Must be aged 18 or above.

Given these qualifiers, it is ensured that the responses collected are relevant to the study.
3.1.4 Survey Flowchart

*Figure 8* is an overview of the survey structure; yellow represents mutual questions, questions given to cyclists are in blue and questions given to drivers are in green. *Figure 9* highlights the Overtaking Cyclists’ Road Safety Survey in detail.
Figure 9. Overtaking Cyclists' Road Safety Survey

What is your Gender?
- Female
- Male

What is your age?
- 18-21
- 21-25
- 26-30
- 31-35
- 36-40
- 41-45
- 46-50
- 51-55
- 56-60
- 61-65
- 66-70
- 71-75
- 75 and above

Which of the following are you?
- Driver only (do not cycle)
- Cyclist only (do not drive)
- Driver and Cyclist

Cyclist only

Cyclist only (do not drive)

You are about to enter the cyclist component of this survey. Please kindly respond to the following questions from a cyclist’s perspective. How many years of on road cycling experience do you have?
- less than 2 years
- 2 - 5 years
- 6 - 10 years
- 11 - 15 years
- more than 15 years

How many days per week do you cycle?
- 1 day/week
- 2-3 days/week
- 3-5 days/week
- 6-7 days/week

Driver only

Driver only (do not cycle)

You are about to enter the driver’s component of this survey. Please kindly respond to the following questions from a driver’s perspective. How many days a week do you drive?
- 1 day/week
- 2 days/week
- 3-5 days/week
- 6-7 days/week

How many years of driving experience do you have?
- less than 1 year
- 2-3 years
- 3-4 years
- 4-10 years
- 10-20 years
- more than 20 years
Which of the following issue(s) do you think have made it difficult for drivers to allow a sufficient overtaking distance when passing you? You may select more than one response.
- Weather
- Distance of cyclist(s) from kerb
- Cyclists’ cycling behaviour
- Width of road
- Limited visibility
- Parked cars
- Oncoming vehicles
- Congestion
- Terrain
- Speed of car(s)
- Speed of bicycle(s)
- Others

As a driver, how difficult is it to control a specified overtaking distance when passing bicycles?
- Easy
- Possible
- Difficult
- Very difficult
- I have never had difficulty

Which of the following issue(s) have made it difficult for you to allow a sufficient overtaking distance when passing a bicycle? You may choose more than one response.
- Weather
- Distance of cyclist(s) from kerb
- Cyclists’ cycling behaviour
- Width of road
- Limited visibility
- Parked cars
- Oncoming vehicles
- Congestion
- Terrain
- Speed of car(s)
- Slow speed of bicycle(s)
- Others

Do you ever feel that cyclists’ safety is at risk when you are overtaking them?
- Always
- Sometimes
- Never

This study will be correlated with a 15 minutes computer driving simulation. This driving simulation program will take place in January 2015. Please kindly fill in your email address if you would like a chance to participate in this simulation program.
- I will not participate
- Yes, I would like to participate

Email:

Are you aware of the fact that countries such as the US and some European countries (Belgium, France etc.) have legalized a specified ‘Minimum Overtaking Distance’?
- Yes
- No
Do you agree that there is a need to develop a safer cycling environment?
- Strongly Agree
- Agree
- I don’t know
- Disagree
- Strongly Disagree

Please suggest ways that the cycling environment can be improved.

Do you think a specified 'Minimum Overtaking Distance' should be legalized?
- Yes
- No
- Unsure

How far do you think the 'Minimum Overtaking Distance' should be?
- 0.5 m
- 1.0 m
- 1.5 m
- 2.0 m

Were you ever involved in an accident that was caused by overtaking a cyclist?
- Yes
- No

Was the accident majorly caused by the car or the bicycle?
- Car
- Bicycle

Do you think the accident could have been avoided if there was a specified 'Minimum Overtaking Distance'?
- Yes
- No
- Uncertain

Please kindly provide us with further details of your personal experiences. i.e. What are some of the circumstances, which can induce potential accidents between cars and cyclists? We do appreciate detail descriptions of your personal experiences, such as weather, visibility, lighting, clothing of the cyclist etc.

Please kindly fill in your email address below for the chance to win 1 of 8 MyBus1 Travel 10 concession ticket.

Please enter you email address for the chance to win 1 of 2 FREE BicycleNSW membership.

End of Survey
3.2 Driving Simulation

This study is commissioned to experiment with the newly established UNSW iCITI TRACSlab, the purpose is to focus on the exploration of the software and operation of the new equipment. It is to develop a foundation for later studies in this area, and to explore the functions and possible opportunities in this program. In relevance to this study, a common overtaking situation was developed to investigate driver’s overtaking behaviour. This study is the first project to experiment with the new program, which contributions to the establishment of the UNSW Research Centre for Integrated Transport Innovation.

3.2.1 Simulation Design and Administration

This study was commissioned to use a driving simulation package powered by Realtime Technology Inc. (RTI), it was simulated with the combination of the SimVista™ and SimCreator® software.

A typical Sydney Suburban drive was developed to simulate a common overtaking situation. The design of this experiment is limited to the following factors:

- Time Constraint for this study, for it is to be completed during a Summer Semester;
- The installation of new programs and equipment;
- Official training of the program scheduled at a later stage of this experiment;
- The first project to experiment with the new program, thus numerous technical difficulties has to be resolved;
- To develop a static environment that can be utilized in later studies.
The following design was being developed after taking into consideration of the restrictions of this experiment.

- 4 lanes road (common Sydney suburban road)
- Speed of subject: 40 to 50 km/h
- Parked cars on the left lanes
- Static environment as to typical Sydney Suburbs
- **Simulation Sequence:**
  - 2 x 10 minutes drive
  - 1\textsuperscript{st} drive with no action (allow participants to be familiar with the road)
  - 2\textsuperscript{nd} drive with action
  - Ambient traffic that does not interfere with subject
    - Approximately 8 minutes **warm up drive** at the start of the simulation
      - Straight road with no traffic lights and junctions
    - **Action** starts after a left turn (duration: approx. 3 minutes)
      - Participant instructed to make a left turn after the warm up drive
      - Bicycle appear: ahead of subject after the left turn
        - Bicycle slows down, travel at 35km/h
    - Participant instructed to make a left turn and park.
      - (End of Simulation)

### 3.2.2 Sampling Frame and Data Collection

The major purpose of this driving simulation is to experiment with the simulation-programming component. It is to analyze the driver's behavior in an overtaking situation. A list of volunteered participants was generated from the survey, 10 participants will be chosen due to time constraints.
To ensure that participants are NSW drivers of age 18 and above, they had to sign an agreement to declare suited for the simulation experiment.

The type of data collected during the driving simulation is indicated below:

- From Start to End
  - Speed of subject
- From Action to End
  - Speed of subject
  - Response of subject
- Reaction time
- Reactions:
  - Overtook
    - Overtaking Distance
  - Slow down
  - Stop or otherwise

In this particular overtaking situation, the collected data will help analyze the driver’s behavior. The nature of participants (age, gender etc.) will not be considered in this experiment due to the mentioned limitations.

3.2.3 Simulation Programming

This simulation was commissioned to program using SimVista™ and SimCreator®, then it was generated onto the driving simulators (Figure 11). Five driving simulators that generated real time driving scenarios via a master computer were installed in the UNSW iCITI TRACSlab. (Figure 10).
Figure 10. Driving Simulator

Figure 11. Simulated Scenario (Demo)
The simulation programming process can be separated into two main components. The first component is to create a Static Environment using SimVista™, static environment include:

- Road Tiles
- Parked Cars
- Trees
- Buildings
- Road Junctions
- Traffic lights;
- Road signs
- Terrain
- Streetlights etc.

After creating the static environment, sensors and markers were placed in the static environment to guide actions in SimCreator®. The SimVista™ program interface can be seen in Figure 12. Plan view of the completed static environment simulation is shown in Figure 13, the action and warm up section of the drive is indicated. An overview of the entire driving sequence can be seen in Figure 14, please refer to Appendix B for detail documentation.
The second component requires the use of SimCreator®, this program generates actions and animations. The file created using SimVista™ is then linked to SimCreator® for the program to develop animations in the environment created. Elements to be created in SimCreator® for this experiment include:

- Weather (Day time, Sunny)
- Ambient Traffic (do not interfere subject)
- Pedestrians
- Action: Bicycle moving at 35km/h after warm up drive (enter after left turn)

JavaScript is a required knowledge for SimCreator®. The graphical model is generated by complex plant models using power flow-style modeling methods. The SimCreator® interface can be seen in Figure 15. The driving simulation can be finalized after inserting the required JavaScript for the designed actions. The Log and flow-style modeling diagram of this simulation are displayed in Figure 16. To avoid technical errors during the actual experiment, mock-ups of the driving simulation were performed.
Figure 16. Modeling diagram
4. Overtaking Cyclists’ Road Safety Survey

873 responses, as a representative number of the population were collected from drivers and/or cyclists in New South Wales. The survey samples collected can reflect the statistics and perceptions of the general population. The main findings from the Overtaking Cyclists’ Road Safety Survey is displayed and discussed in this section. In the first section, quantitative responses are displayed by the use of graphs and tables.

4.1 Data Processing

The response rate from the online survey was approximately 82.5%, which was a total of 873 responses. The survey was separated into three streams, with 687 responses for ‘Driver and Cyclist’, 113 responses for ‘Driver only (do not cycle)’ and 74 responses for ‘Cyclist only (do not drive)’. As the survey sample did not reflect the cyclist:driver ratio in New South Wales, the responses for the three streams were analyzed independently to ensure that the majority of ‘Drivers and Cyclists’ do not deviate from the overall result.
4.2 Main Findings

4.2.1 Gender and Age of Survey Sample

33% of the driver respondents were female whilst 67% were male. 30% of the cyclist respondents were female, and 70% were male. Research from *Australian Bureau of Statistics* shows one third of the total motor vehicle drivers on New South Wales and Australian roads are females. Similar to cyclists, a report from World Transport Policy and Practice shows that one third of the cyclists in New South Wales are female. (*ABS 2013, World Transport Policy and Practice 2012*)

The statistics collected from the survey responses approximately reflects the gender ratio of New South Wales’ population. The genders of cyclist and driver participants are demonstrated in *Figure 17*.

![Figure 17. Gender Ratio of Survey Sample](image-url)
The age bracket with the highest number of drivers was 18-25 year olds, contributing to 49% of the totally number of drivers. It was shown that the majority of cyclists tend to be older in comparison to drivers, having the highest number of cyclists in the age group of 26-35 and 36-45. 49% of the drivers in comparison to 18% of ‘Cyclist only’ and 5% of ‘Cyclist and Driver’, a significant difference between the number of drivers and cyclists can be seen in the 18-25 age band. No drivers were aged 75 and above, while a small number of cyclists in this age band was recorded. Figure 18 shows a detail distribution of cyclist and driver age range.

![Figure 18. Age of Survey Sample](image-url)
4.2.2 Driving Habits of Survey Sample

From the survey, 34% of the drivers drive 6-7 days per week, while 32% drive 3-5 days per week. Showing that the majority of the respondents drive more than 3 days per week. It was found that 36% of the respondents drive as a form of transportation to work, whilst 19% drive to run errands. These collected data can assist in differentiating and to further understand focus groups of respondents in later responses. How frequent the respondents drive is represented in Figure 19.

Figure 19. Frequency of Driving
Majority of the drivers (64%) have more than 20 years of driving experience, whilst the number of respondents with less than 20 years of driving experience have significantly decreased. Less than 1% of the surveyed drivers have less than one year of driving experience. This collected data can help identify the relationship between driving experience and driving behavior in later analysis. Figure 20 summarizes respondents’ driving experience.

Figure 20. Years of Driving Experience
4.2.3 Cycling Habits of Survey Sample

42% of the sample cycles 3 to 5 days a week and 27% cycles 2 to 3 times a week. It can be seen that more than half of the survey sample ride a bicycle more than 3 days a week. In order to understand the nature of their use of bicycle, they were asked to highlight their reasons for cycling. Respondents were allowed to select more than one response to their reasons to cycle. 62% cycle as a recreational interest, whilst 50% cycles as a form of transportation to work. 46% cycles as a weekend activity, 30% cycles as a group and 24% cycles to run errands. Figure 21 summarizes the number of days per week the sample cycles.

![Frequency of Cycling](image)

Figure 21. Frequency of Cycling
Majority of the surveyed cyclists (45%) have more than 15 years of cycling experience on road. It can be seen that more than half of the surveyed sample have been cycling on road for more than 10 years. The years cycling experience data collected can help differentiate and characterize responses in later questions, which allow this research to provide in depth study on the different behaviour of particular focus groups. Figure 22 displays the cycling experience distribution of the surveyed cyclists.

Figure 22. Cycling Experience on Road
4.2.3 Perception towards the Existing Cycling Environment

94% of the surveyed sample “Strongly Agree” or “Agree” that there is a need to develop a safer cycling environment, whilst none of the respondents “Disagree” or “Strongly Disagree” (Figure 23). It can be seen that the majority road users believe the existing cycling environment can be improved. ‘Minimum Overtaking Distance’ being the most prominent strategy to improve cyclists’ on road safety is being explored in this study. Analyzing the collected survey data will demonstrate the effectiveness of a specified ‘Minimum Overtaking Distance’ in improving cyclists’ on road safety.

Figure 23. Need to Develop a Safer Cycling Environment
4.2.4 Awareness towards Existing Overtaking Guideline

The literature reviewed earlier in this study has shown that there are overtaking guidelines in NSW. The NSW RTA guideline on overtaking states that “If you are overtaking a bicycle rider, give them at least 1 metre of space to the side in a 50km/h zone. If the speed limit is higher, you need to give the cyclist more space.” In order to analyze the effectiveness of existing overtaking guidelines, the guideline stated above was provided in the questions, where respondents were asked whether they are aware of it.

No significantly dominating figure can be seen in the result. Only 42% of the surveyed respondents know the exact detail of the guideline, whilst 39% are aware of it but not knowing the exact detail. Approximately 19% of the respondents were completely unaware of such overtaking guideline. There is a contrasting difference between ‘Driver only’ and ‘Driver & Cyclist’ responses in this question; larger number of ‘Driver and Cyclist’ (53%) answered “Yes” in comparison to ‘Driver only’ (30%). Contrastingly, more ‘Driver only’ respondents answered “No” and “Yes, but not the exact details” in comparison to ‘Driver & Cyclist’. Thus, it can be seen that drivers who cyclists has a better knowledge of the existing overtaking guideline.

However, it is able to reflect that less than 50% of road users know the exact detail of the existing guideline, showing that it has not been effective in protecting bicycle riders on road. The lack of awareness towards overtaking bicycle guideline can be concluded from this question, drivers who do not cycle in particular. Actions to increase road users awareness towards overtaking bicycle safety have to be done. Figure 24 summarizes the survey responses towards overtaking guideline awareness.
Are you aware of the NSW RTA guideline on overtaking?

"If you are overtaking a bicycle rider, give them at least 1 metre of space to the side in a 50km/h zone. If the speed limit is higher, you need to give the cyclist more space."

![Bar chart showing respondent's awareness towards the RTA overtaking guideline](image)

**Figure 24. Awareness towards existing NSW RTA overtaking guideline**
4.2.5 Driving Behaviour of Survey Sample

It is arguable that an overtaking guideline may not be able to effectively protect cyclists on road; however it is to understand a driver’s most probable action when cyclist(s) interfere with their driving. In order to study their general behavior, drivers were asked for their general reaction when cyclist(s) interfere with their driving. To interfere is referred to as any positive or negative interaction between the cyclist and driver on the road.

Majority of the respondents (74%) “Slow down and overtake where safe” when cyclist(s) interfere with their driving. 12% of the drivers “Make a lane change if possible” and 9% “Slow down”. It can be seen that a vast majority of drivers will slow down and overtake cyclist(s), thus overtaking cyclists’ road safety has to be studied. Figure 25 summarizes drivers’ reaction when cyclist(s) interfere with their driving.

![Driver's general reaction when cyclist(s) interfere with their driving]

Figure 25. Drivers’ reaction when cyclist(s) interfere with their driving
4.2.6 Perception towards Minimum Overtaking Distance

Drivers were asked whether they feel that cyclists’ safety is at risk when overtaking them (Figure 26). 44% of the surveyed drivers “Sometimes” find that they are at risk, which can be interpreted that they are aware of cyclists’ safety while unable to protect them occasionally. 41% of the respondents “Never” find cyclists safety at risk when overtaking them, it is arguable that this survey sample either takes good care before overtaking or they are unaware of cyclists’ overtaking safety. Lastly, 15% “Always” think that cyclists are at risk when overtaking, expresses their urge for a safer overtaking cyclists’ road system.

To further understand reasons to why respondents answered “Never”, the survey sample was studied. 43% of the respondents who answered “Never” are ‘Driver and Cyclist’, whilst 30% are ‘Drivers only’. Approximately 70% of the respondents for “Never” have more than 10 years of driving experience. This might show that respondents are more confident about their judgment, thus “Never” feel that cyclists’ safety is at risk when overtaking. Let alone cyclists are aware of their own risk in overtaking situations; it can be seen that more than half of the driver respondents are finding a certain extent of risk involved in overtaking situations. Thus, it is to study whether a specified ‘Minimum Overtaking Distance’ is an effective strategy to decrease their risk.

![Pie chart showing the distribution of responses to the question: Do drivers feel that cyclists' safety is at risk when overtaking them?](Figure 26. Risk of Cyclists in Overtaking Situations (Driver's Perspective))
To understand the importance of ‘Minimum Overtaking Distance’ for a cyclist, respondents were asked to rate “How important is a ‘Minimum Overtaking Distance’ when car(s) are overtaking bicycle(s).” It was found that 99% of the surveyed cyclists believe that is “Highly Important” or “Important”, while 0% thinks that it is “Unimportant” or “Highly Unimportant”. Thus, it is evident that a specified ‘Minimum Overtaking Distance’ is an important aspect to cyclists when cars are overtaking them. Figure 27 illustrates the responses from surveyed cyclists.

"How important is a 'Minimum Overtaking Distance' when car(s) are overtaking bicycle(s)?" (Cyclists' Perspective)

Figure 27. Importance of 'Minimum Overtaking Distance' from Cyclists’ Perspective
A ‘Minimum Overtaking Distance’ is shown to be important to cyclists, how well drivers control their overtaking distance was investigated (Figure 28). From a cyclist’s perspective, it was shown that 40% believe drivers are “Poor” or “Extremely Poor” at controlling their overtaking distance when passing cyclists. Majority of the cyclist respondents think they are “Fair”, whilst only 15% think that they are “Very good” or “Good”. It can be seen that cyclists tend to believe that drivers can have a better control when passing them. To understand the reasons to why they have been “Poor” or “Extremely Poor” at overtaking cyclists, barriers that have made it difficult for drivers to control their overtaking distance will be discussed later in this section.

Figure 28. Cyclist’s Perspective of Driver’s control of Overtaking Distance
In order to investigate whether there is a particular focus group of road users that are more careless when overtaking, respondents were asked to name the groups of drivers. 25% of the respondents named truck drivers, 23% named P-plate or young drivers, 22% named Taxi drivers and 21% named Bus drivers (Figure 29). It can be seen that the majority of the categories named drives as an occupation. Specific education and promotion for these particular groups of drivers can be done to improve their awareness towards overtaking cyclists’ safety. Inclusion of more overtaking cyclist safety questions can be included in the driver’s license exams to improve the awareness of this focus group.

Figure 29. Groups of drivers named to be more careless when overtaking cyclists
It can be summarized from the previous analyzes that majority of the cyclists believe that an overtaking distance is important when cars are passing them. It is to investigate the perception of drivers and cyclists towards the legalization of a specified 'Minimum Overtaking Distance'. Respondents were asked whether they think a specified ‘Minimum Overtaking Distance’ should be legalized (Figure 30). 75% of the survey sample believes that it should be legalized, whilst 13% think it should not. In this question, a contrasting perception between ‘Driver only’ and ‘Driver & Cyclist’ can be seen. Approximately 90% of the ‘Cyclist only’ and ‘Driver & Cyclist’ respondents believe that it should be legalized, while only 44% of the ‘Drivers only’ believe so. Thus, there is a contrasting perception towards cyclists’ overtaking safety between drivers who cycles and do not cycle. This might be caused by a driver’s lack of awareness towards the cycling community, whilst drivers that cycles have a better understanding of the needs within the cycling environment.

Figure 30. Perception towards the legalization of a specified 'Minimum Overtaking Distance'
It was shown that majority of the road users believe that a specified ‘Minimum Overtaking Distance’ should be legalized. Researches have investigated suitable overtaking distance that is believed to be the most effective in creating a bicycle inclusive driving environment. In this study, it is to investigate road user’s perception towards the most suitable ‘Minimum Overtaking Distance’ (Figure 31). The responses were reasonably balanced between the three main respondents categories, 67% of ‘Drivers only’, 56% of ‘Driver and Cyclist’ and 55% of ‘Cyclist only’ believe that it should be 1 metre. More ‘Cyclist only’ and ‘Driver and Cyclist’ think that 1.5 metre is the most suitable in comparison to ‘Driver only’ responses. It is inevitable that majority of the road users believe that 1 metre is the most suitable ‘Minimum Overtaking Distance’ when car(s) are passing cyclist(s).

"How far should the 'Minimum Overtaking Distance' be?"

- **0.5 Metre (m)**
  - Driver only: 7%
  - Driver and Cyclist: 1%
  - Cyclist only: 1%
  - Mean: 3%

- **1 Metre (m)**
  - Driver only: 67%
  - Driver and Cyclist: 56%
  - Cyclist only: 55%
  - Mean: 59%

- **1.5 Metre (m)**
  - Driver only: 21%
  - Driver and Cyclist: 35%
  - Cyclist only: 37%
  - Mean: 31%

- **2 Metre (m)**
  - Driver only: 4%
  - Driver and Cyclist: 8%
  - Cyclist only: 7%
  - Mean: 7%

*Figure 31. How far should the 'Minimum Overtaking Distance' be?*
Legalizing a specified ‘Minimum Overtaking Distance’ can be a suitable strategy to improve overtaking cyclists’ road safety. In order to understand whether it is a fair solution for drivers, we have to consider a driver’s ability to judge a specified overtaking distance when they are driving. Drivers were asked, “How difficult is it to provide a ‘Specified Overtaking Distance' when passing bicycles?” (Figure 32)

Majority of the surveyed drivers believe that it is possible (40%), while 28% think that it would be easy to control and 17% never had difficulties. 15% think it would be “Difficult” or “Very Difficult”. It can be seen that approximately 85% believe that they have the ability to control a “Specified” overtaking distance when passing bicycles. Thus, implementing a specified ‘Minimum Overtaking Distance’ would not be a concern for at least 85% of road users. Barriers that may have caused a difficulty for the remaining 15% of the drivers to remain a sufficient overtaking distance when passing bicycles will be discussed in the next section.

"As a driver, how difficult is it to control a 'Specified Overtaking Distance' when passing bicycles?"

Figure 62. Level of Difficulty to provide a 'Specified Overtaking Distance'
4.2.7 Barriers to provide an Overtaking Distance

In order to understand the reasons that may have led to a difficulty in remaining sufficient overtaking distance when cars are passing bicycles, respondents were asked to select the possible causes. 74% of the respondents believe that “Width of Road” is one of the major barriers to allow sufficient distance when overtaking. 59% think that oncoming vehicles have affected their ability, and 47% think “Parked Cars” have made it difficult to remain sufficient distance when overtaking. Strategies to improve the named barriers can make ‘Minimum Overtaking Distance’ to be more manageable for drivers. Better collaboration strategies between drivers and cyclist can be proposed for cyclists to ease driver’s overtaking. Figure 33 displayed the other barriers that may have prevented a sufficient overtaking distance.

**Barriers for cars to provide sufficient Overtaking Distance when passing bicycles**

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather</td>
<td>8.25%</td>
</tr>
<tr>
<td>Distance of cyclist(s) from kerb</td>
<td>32.13%</td>
</tr>
<tr>
<td>Cyclists’ cycling behaviour</td>
<td>32.25%</td>
</tr>
<tr>
<td>Width of road</td>
<td>73.75%</td>
</tr>
<tr>
<td>Limited visibility</td>
<td>20.5%</td>
</tr>
<tr>
<td>Parked cars</td>
<td>46.75%</td>
</tr>
<tr>
<td>Oncoming vehicles</td>
<td>58.88%</td>
</tr>
<tr>
<td>Congestion</td>
<td>31%</td>
</tr>
<tr>
<td>Terrain</td>
<td>9.5%</td>
</tr>
<tr>
<td>Speed of car(s)</td>
<td>15.5%</td>
</tr>
<tr>
<td>Slow speed of bicycle(s)</td>
<td>10.13%</td>
</tr>
<tr>
<td>Others</td>
<td>13.63%</td>
</tr>
</tbody>
</table>

*Figure 33. Barriers to provide sufficient Overtaking Distance when passing bicycles*
4.4 Important Limitations

There are a number of limitations in this survey sample. Although its aim is to investigate the effectiveness of ‘Minimum Overtaking Distance’ in improving cyclist’s safety, however, only a subjective sense of safety can be defined in this survey. The use of this survey was unable to scientifically proof that a ‘Minimum Overtaking Distance’ can decrease accident rates. However, research by Rutgers University stated that subjective safety is a major consideration in road safety.

The surveyed sample was limited to the state of New South Wales in Australia. It is arguable that it will be able to represent the majority of road users in Australia, as the concluded findings can only reflect upon the road users of New South Wales. 873 of collected responses is a significant number of data to represent the population, however there is a lack of ‘Drivers only’ and ‘Cyclist only’ response in comparison to ‘Driver and Cyclist’. The three sets of data were analyzed independently to avoid the dominating results from ‘Drivers and Cyclist’, while the calculated mean is pure reference and does not represent the NSW road user population. This is due to the fact that the ‘Drivers only’ dominates the road user population in NSW.
4.5 Conclusion

In most situations, majority of the drivers tend to slow down and overtake cyclists when safe. 99% of the cyclists think that a sufficient overtaking distance is important to them, while only 15% of the drivers have a good control over their passing distance. In order to improve the existing overtaking risk experienced by cyclists, 75% of the road users believe that a specified ‘Minimum Overtaking Distance’ should be legalized, whilst 60% think that 1 metre is the most suitable distance. It is shown that the ability to control a ‘Specified Overtaking Distance’ would not be a concern for at least 85% of drivers. It can be concluded that a specified ‘Minimum Overtaking Distance’ can help improve safety of cyclists’ on road. It can improve subjective sense of safety for both existing cyclists and non-cyclists. Thus, a specified ‘Minimum Overtaking Distance’ can help develop a safer on road cycling environment, consequently increase cycling participants.

Strategies to improve overtaking can build on the key findings as shown below:

**Barriers to provide sufficient overtaking distance**

Four dominant barriers were found:

- Width of the road
- Oncoming vehicles
- Cyclists’ cycling behavior (distance from kerb)
- Congestion

*There is a need to promote, motivate and propose effective initiatives for the following key focus groups that are more careless when overtaking.*

Four dominant categories were found:

- Truck Drivers
- P-plate and young drivers
- Taxi Drivers
- Bus Drivers
5. Driving Simulation

5.1 Main Findings

It took approximately one month for the static environment of the simulation to be completed. The simulation software was explored and the key findings are displayed in this section.

The driving simulation is a commissioned component for this research. The focus of it is to explore the simulation software from the newly established UNSW iCITI TRACSlab. The purpose is to explore the potential and possibilities of this software to develop a Cyclist Road Safety Study Simulation for later studies. The simulation created in this study is a useful foundation for future studies; investigators can build on the existing SimVista™ static environment and edit the coding in SimCreator®.

From a 3 days training conducted by Realtime Technologies and personal experience with this software throughout the period of study, the potential of this software can be concluded as the following:

- Complex cyclist road safety scenarios can be simulated by this program.
- The experimental subject of up to 5 drivers and 1 cyclist can be tested at the same time. Thus interactions between 5 driver subjects and 1 cyclist subject can be investigated in a simulation.
- Variables that can be simulated include:
  - Pedestrian(s)- quantity, speed, path, direction etc.
  - Neighboring Vehicle(s)- quantity, type, speed, direction, path etc.
  - Bicycle(s)- quantity, speed, direction, path etc.
  - Time of Day
  - Weather- Snow (Heavy, Light), Rain (Heavy, Light), Fog (Heavy, Light) etc.
  - Traffic Light(s)- control of traffic light system
• Environment that can be developed include:
  o Terrain- Slopes, Uphill, Downhill
  o Road- number of lanes, pedestrian walkway, junctions
  o Road Signs
  o Traffic lights
  o Static cars
  o Vegetation
  o Buildings- houses, skyscrapers, customize using AutoCAD
  o Street lights
  o Textures- Desert, type of grass, concrete etc.

• The type of collected data depends on the experiment. Numerous data can be collected including, speed, number of crashes, distance, time etc. Data can be generated as graphs from the software.

Recommendations to ease programming:

• Generate the action on a basic tile using SimCreator, limit to minimal components and avoid publishing aspects that do not impact the action.

• Publishing large files from SimVista is very time consuming. Do not publish the final static environment to develop animation. Test the model and JavaScript input with minimal components from SimVista.

• Save the log, JavaScript input and flow chart once the desired simulation ran via SimCreator.

• Error may induce when running simulation on SimCreator, check run log.

• Do not complete entire static environment on SimVista before publishing to SimCreator. Publish file to SimCreator continually and input simulation setting to ensure that no technical error occurs.

• Static environment files created in SimVista are very large; it will disable or takes large amount of time to be published. Create static environment by single tiles, then create tile as an object.

• Objects created from single tiles can be reused, which saves time and minimize file size when publish onto SimCreator.
• Note that the road tiles from SimVista can be created as left-hand driving and right-hand driving.

The simulation created from this study is a valuable tool for future studies. The static environment require a large amount of time to be developed, future experiments can build on the existing static environment of this study. Later experiments can focus on the development of animated scenarios without spending extensive time to create the static environment. More complex overtaking scenarios can be designed by varying the number of cyclists, neighboring cars, lanes of road, speed of cars and cyclist(s), cyclists’ distance to kerb etc.

5.2 Important Limitations

The experiment was unable to proceed onto data collection stage. This is due to various limitation of this experiment. These limitations include:

• Time Constraint for this study, it is to be completed during a Summer Semester;
• The installation of new programs and equipment;
• Official training of the program scheduled at a later stage of this experiment;
• The first project to experiment with the new program, thus numerous technical difficulties has to be resolved;
• To develop a static environment that can be utilized in later studies.


5.3 Conclusion

This study has made a valuable contribution towards the establishment of the iCITI TRACSlab at the UNSW Research Centre for Integrated Transport System. It can be concluded that the UNSW iCITI TRACSlab software has a huge potential and possibilities in creating complex overtaking cyclist experiments. Simulations can be customized according to specific location and scenarios. Future investigations can be build on the simulation created in this study by varying ambient traffic, the number of cyclists, cyclists’ speed, lanes of road and cyclists’ distance to kerb. The data collected can reflect the real time behavioral responses of drivers in overtaking situations.

Remarks: The simulation files can be accessed from the attached DVD.
7. Improvements & Areas for Further Studies

The experimental procedures of this study can be improved by various modifications; and the research findings have a huge potential in directing further studies. The survey structure can be improved by having less open-ended questions, or having a smaller word limit. 873 responses were collected, whilst reading 500 words responses became a challenge when interpreting data. An alternative method can be used to generate a survey sample that matches the driver:cyclist ratio, where the survey results can then be an unbiased representation of the population. This study was built upon statistics that was collected from the New South Wales road users. It can be expended by conducting surveys in different states and territories in Australia, to generate comparative studies between drivers and cyclists in different areas.

The driving simulation did not proceed to the data collection stage. Although this is due to the external factors of UNSW iCITI TRACSlab’s installation schedule, a better communication with lab members might result a better progress. However, this study has created a valuable foundation that directs further studies into overtaking cyclists’ road safety. Experiments can simulate different overtaking situations to study a driver’s behavioral response. Their responses can be further studied by investigating distinguish behaviour of specific focus groups. The following overtaking situations can be investigated by varying:

- The number of cyclists
- Speed of cyclist(s)
- Cyclist(s) distance to kerb
- Speed of driver(s)
- Ambient traffic
- Terrain
- Road formation – number of lanes, junctions, junctions with or without traffic lights etc.

Further studies can help implement strategies that create a better on road cycling environment that can benefit both cyclists and motor vehicles.
6. Research Conclusions

‘Minimum Overtaking Distance’ is an effective strategy to improve overtaking cyclists’ road safety. In most situations, majority of the drivers tend to slow down and overtake cyclists when safe. 99% of the cyclists think that a sufficient overtaking distance is important to them, while only 15% of the drivers have a good control over their passing distance. In order to improve the existing overtaking risk experienced by cyclists, 75% of the road users believe that a specified ‘Minimum Overtaking Distance’ should be legalized, whilst 60% think that 1 metre is the most suitable distance. It was shown that the ability to control a ‘Specified Overtaking Distance’ would not be a concern for at least 85% of drivers. It can be concluded that a specified ‘Minimum Overtaking Distance’ can help improve the safety of cyclists’ on road. It can effectively improve subjective sense of safety for both existing cyclists and non-cyclists.

Strategies to improve overtaking can build on the key findings as shown below:

**Barriers to provide sufficient overtaking distance**

Four dominant barriers were found:

- Width of the road
- Oncoming vehicles
- Cyclists’ cycling behavior (distance from kerb)
- Congestion

*There is a need to promote, motivate and propose effective initiatives for the following key focus groups that are more careless when overtaking.*

Four dominant categories were found:

- Truck Drivers
- P-plate and young drivers
- Taxi Drivers
- Bus Drivers
The UNSW iCITI TRACSlab software has a huge potential and possibilities in creating complex overtaking cyclist experiments for future Overtaking Cyclists’ Safety Studies. This area of study can be further explored by building upon the simulation generated from this study. Experiments to investigate a driver’s behavioral response in different overtaking cyclists’ situations can be developed by varying the number of cyclists, cyclists’ speed, distance to kerb, terrain etc.
7. Reference


8. Appendix A
Survey Questions

The University of New South Wales PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM Overtake Cyclists’ Road Safety Study by Pearl Lee. You are invited to participate in a cyclist road safety study in relation to driver’s behaviour when overtaking a cyclist. To aim to learn from drivers’ and cyclists’ perspective, the importance of drivers’ ‘Minimum Overtaking Distance’ when passing cyclist(s). You were selected as a possible participant in this study because you are a driver and/or a cyclist and are above 18 years of age. If you decide to participate, I ask that you complete a survey that should take approximately 10 minutes of your time. This survey will look at your current driving/cycling behaviour and experiences, and your view towards the ‘Minimum Overtaking Distance’. The data collected will be used by the researcher (Pearl Lee) to assist with analysis later on and will only be used for research purposes. No discomfort, inconvenience, or risk is expected to arise due to your participation in this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission, except as required by law. If you give your permission by continuing to, and completing, the survey, I plan to discuss the results as grouped data where it will be published as an honours thesis. In this research paper, information will be provided in such a way that you cannot be identified. If you complete the survey, you have the chance to win 1 of 8 MyBus Travel 10 concession tickets. Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone 9385 4234, fax 9385 6648, email ethics.gmo@unsw.edu.au). Any complaint you make will be investigated promptly and you will be informed about the outcome. If you would like to receive a summary of research findings, please send an email at pearl.lee@student.unsw.edu.au with the subject “Overtaking Cyclists’ Road Safety”. I will send you a report as soon as the data has been analysed. Your decision whether or not to participate will not prejudice your future relations with the University of New South Wales. If you decide to participate, you are free to withdraw your consent and discontinue participation at any time without prejudice. Please contact Pearl Lee (pearl.lee@student.unsw.edu.au) about your revocation of consent after the survey is submitted, your data will then be extracted from the data set. If you have any additional questions later, Professor Stephen Moore, Senior Lecturer in Waste and Environmental Management (s.moore@unsw.edu.au) will be happy to answer them. You are making a decision whether or not to participate. Clicking on the “I agree to participate” button below indicates that, having read the information above, you have decided to participate. If you do not agree, please click on the “I do not agree to participate” button or simply exit the survey now.

Answer options:
- I agree to participate
- I do not agree to participate

Q 2
Question type: Pick one or ‘other’
What is your gender?
Answer options:
- Female
- Male

Q 3
Question type: Pick one or ‘other’
What is your age?
Answer options:
- 18 - 21
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
Show All
Q. 1

Question type: Pick one or 'other'

Which of the following are you?

Answer options:
- Driver only (do not cycle)
- Cyclist only (do not drive)
- Driver &amp; Cyclist

Q. 2

Question type: Pick one or 'other'

You are about to enter the driver's component of this survey. Please kindly respond to the following questions from a driver's perspective. How many days a week do you drive?

Answer options:
- 1 day/week
- 2 days/week
- 3-5 days/week
- 6-7 days/week

Q. 3

Question type: Pick one or 'other'

How many years of driving experience do you have?

Answer options:
- 0-1 year
- 2-3 years
- 4-5 years
- 6-10 years
- 11-20 years
- &gt;20 years

Q. 4

Question type: Pick one or 'other'

What is your main reason for driving?

Answer options:
- To work
- To school
- Weekend driving
- Leisure
- Run errands
- Family purpose
- Other

Q. 5

Question type: Pick one or 'other'

What is your general reaction when cyclists interfere with your driving?

Answer options:
- Slow down
- Overtake cyclist(s)
- Stop
- Make a lane change if possible
- Slow down and overtake when safe
- Other

Q. 6

Question type: Pick one or 'other'

Are you aware of the following NSW RTA guideline on overtaking? "If you are overtaking a bicycle rider, give them at least 1 metre of space to the side in a 50km/h zone. If the speed limit is higher, you need to give the cyclist more space." v

Answer options:
- No
- Yes
- Yes, but not the exact details
As a driver, when you are overtaking a bicycle, how important do you think it is for a car to provide overtaking distance?

Answer options:
Highly Important
Important
Neutral
Unimportant
Highly Unimportant

Are you aware of the fact that countries such as the US and some European countries (Belgium, France etc.) have legalized a specified 'Minimum Overtaking Distance'?

Answer options:
Yes
No

Do you agree that there is a need to develop a safer cycling environment?

Answer options:
Strongly Agree
Agree
Disagree
Strongly Disagree

Please suggest ways that the cycling environment can be improved.

Do you think a specified 'Minimum Overtaking Distance' should be legalized?

Answer options:
Yes
No
Unsure

How far do you think the 'Minimum Overtaking Distance' should be?

Answer options:
0.5 m
1.0 m
1.5 m
2.0 m

As a driver, how difficult is it to control a specified overtaking distance when passing bicycles?

Answer options:
Easy
Possible
Difficult
Very difficult
I have never had difficulty
Which of the following issue(s) have made it difficult for you to allow a sufficient overtaking distance when passing a bicycle? You may choose more than one response.

Answer options:
- Weather
- Distance of cyclist(s) from kerb
- Cyclist's cycling behaviour
- Width of road
- Limited visibility
- Parked cars
- Overtaking vehicles
- Congestion
- Terrain
- Snow

Do you ever feel that cyclists' safety is at risk when you are overtaking them?

Answer options:
- Always
- Sometimes
- Never

Were you ever involved in an accident that was caused by overtaking a cyclist?

Answer options:
- Yes
- No

Was the accident mainly caused by the car or the bicycle?

Answer options:
- Car
- Bicycle

Do you think the accident could have been avoided if there was a specified 'Minimum Overtaking Distance'?

Answer options:
- Yes
- No
- Uncertain

Please kindly provide us with further details of your personal experiences, i.e. What are some of the circumstances, which can induce potential accidents between cars and cyclists? We do appreciate detail descriptions of your personal experiences, such as weather, visibility, lighting, clothing of the cyclist etc.
23. This study will be correlated with a 15 minutes computer driving simulation. This driving simulation program will take place in January 2018. Please kindly fill in your email address if you would like a chance to participate in this simulation program.

Answer options:
1. I will not participate.
2. Yes, I would like to participate.

Email:

24. This study will be correlated with a 15 minutes computer driving simulation. This driving simulation program will take place in January 2018. Please kindly fill in your email address if you would like a chance to participate in this driving simulation.

25. You are about to enter the cyclist component of this survey. Please kindly respond to the following questions from a cyclist's perspective. How many years of on-road cycling experience do you have?

Answer options:
1-2 years
2-5 years
6-10 years
11-15 years
15+ years

26. How many days per week do you cycle?

Answer options:
1 day/week
2-3 days/week
3-5 days/week
5-7 days/week

27. What is your main reason(s) for cycling? You may select more than one response

Answer options:
To work
To school
Weekend cycling
Mountain cyclist
Recreational
Fun exercise
Member of cycling club(s)
Group rides
Other
Show all
As a cyclist, when a car is overtaking bicycle(s), how important do you think a 'Minimum Overtaking Distance' is?

Answer options:
- Highly Important
- Important
- Neutral
- Unimportant

(228 AND 06.02) ----> 022

Are you aware of the fact that countries such as the US and some European countries (Belgium, France etc.) have legalized a specified 'Minimum Overtaking Distance'?

Answer options:
- Yes
- No

As a cyclist, how well do you think drivers control their overtaking distance when passing you?

Answer options:
- Very Good ----> 032
- Good ----> 032
- Fair ----> X 033
- Poor ----> X 033
- Extremely poor ----> 031

What are the particular group(s) of drivers that tend to have more dangerous driving habits? (e.g., Taxi drivers, truck drivers etc.)

Do you ever feel that your safety is at risk when cars are overtaking you?

Answer options:
- Always
- Sometimes
- Never

(032 AND 06.03) ----> 032

Do you agree that there is a need to develop a safer cycling environment?

Answer options:
- Strongly Agree ----> 031
- Agree ----> 031
- I don't know ----> 035
- Disagree ----> 035

Please suggest ways that the cycling environment can be improved.
Which of the following issue(s) do you think have made it difficult for drivers to allow a sufficient overtaking distance when passing you? You may select more than one response.

Answer options:
- Weather
- Distance of cyclist(s) from kerb
- Cyclist(s) cycling behaviour
- Width of road
- Limited visibility
- Parked cars
- Oncoming vehicles
- Congestion
- Terrain

Show All

Do you think a specified 'Minimum Overtaking Distance' should be legalized?

Answer options:
- Yes
- No

How far do you think a 'Minimum Overtaking Distance' should be?

Answer options:
- 0.5 m
- 1.0 m
- 1.5 m
- 2.0 m

Were you ever involved in an accident that was caused by vehicle(s) overtaking cyclist(s)?

Answer options:
- Yes
- No

Was the accident majorly caused by the car or the bicycle?

Answer options:
- Car
- Bicycle

Do you think the accident could have been avoided if there was a specified 'Minimum Overtaking Distance'?

Answer options:
- Yes
- No
- Uncertain
Question type: Multi-line text response — often used for comments

Please kindly provide us with further details of your personal experiences. Is what are some of the circumstances, which induced potential accidents between cars and bicycles? We do appreciate detail descriptions of your experiences, such as weather, visibility, lightning, location etc.

Question type: Multi-line text response — often used for comments

Please kindly fill in your email address below for the chance to win 1 of 8 MyBus1 Travel 10 concession ticket.

Question type: Multi-line text response — often used for comments

Please enter you email address for the chance to win 1 of 2 FREE BicycleNSW membership.

Question type: Section header (text only)

End of survey. Thank you so much for your time &amp; contribution!
9. Appendix B
Remarks: For detail survey data please access excel file: Overtaking Cyclist Road Safety Survey Data.xls

- You are making a decision whether or not to participate. Clicking on the "I agree to participate" button below indicates that, having read the information above, you have decided to participate. If you do not agree, please click on the "I do not agree to participate" button or simply exit the survey now.

<table>
<thead>
<tr>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I agree to participate</td>
<td>99.66%</td>
<td>873</td>
</tr>
<tr>
<td>I do not agree to participate</td>
<td>0.34%</td>
<td>3</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 876 respondents; 0 filtered; 1 skipped.

- What is your gender?

<table>
<thead>
<tr>
<th>Gender</th>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td></td>
<td>28.72%</td>
<td>251</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>71.28%</td>
<td>623</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 874 respondents; 0 filtered; 2 skipped.

- What is your age?

<table>
<thead>
<tr>
<th>Age</th>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-21</td>
<td></td>
<td>4.92%</td>
<td>43</td>
</tr>
<tr>
<td>21-25</td>
<td></td>
<td>6.64%</td>
<td>58</td>
</tr>
<tr>
<td>26-30</td>
<td></td>
<td>10.41%</td>
<td>91</td>
</tr>
<tr>
<td>31-35</td>
<td></td>
<td>10.64%</td>
<td>93</td>
</tr>
<tr>
<td>36-40</td>
<td></td>
<td>11.13%</td>
<td>97</td>
</tr>
<tr>
<td>41-45</td>
<td></td>
<td>12.47%</td>
<td>109</td>
</tr>
<tr>
<td>46-50</td>
<td></td>
<td>11.44%</td>
<td>100</td>
</tr>
<tr>
<td>51-55</td>
<td></td>
<td>11.44%</td>
<td>100</td>
</tr>
<tr>
<td>56-60</td>
<td></td>
<td>10.76%</td>
<td>94</td>
</tr>
<tr>
<td>61-65</td>
<td></td>
<td>5.84%</td>
<td>51</td>
</tr>
<tr>
<td>66-70</td>
<td></td>
<td>2.98%</td>
<td>26</td>
</tr>
<tr>
<td>71-75</td>
<td></td>
<td>0.92%</td>
<td>8</td>
</tr>
<tr>
<td>&gt;75</td>
<td></td>
<td>0.46%</td>
<td>4</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 874 respondents; 0 filtered; 2 skipped.

- Which of the following are you?

<table>
<thead>
<tr>
<th>Role</th>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver only (do not cycle)</td>
<td></td>
<td>12.93%</td>
<td>113</td>
</tr>
<tr>
<td>Cyclist only (do not drive)</td>
<td></td>
<td>8.47%</td>
<td>74</td>
</tr>
<tr>
<td>Driver &amp; Cyclist</td>
<td></td>
<td>78.63%</td>
<td>687</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 874 respondents; 0 filtered; 2 skipped.

- You are about to enter the driver's component of this survey. Please kindly respond to the following questions from a driver's perspective.
### How many days a week do you drive?

<table>
<thead>
<tr>
<th>Days per Week</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day/week</td>
<td>15.63%</td>
<td>125</td>
</tr>
<tr>
<td>2 days/week</td>
<td>18.38%</td>
<td>147</td>
</tr>
<tr>
<td>3-5 days/week</td>
<td>32%</td>
<td>256</td>
</tr>
<tr>
<td>6-7 days/week</td>
<td>34%</td>
<td>272</td>
</tr>
</tbody>
</table>

**Export Graph**

Total # of respondents 877. Statistics based on 800 respondents; 0 Filtered; 77 skipped.

### How many years of driving experience do you have?

<table>
<thead>
<tr>
<th>Years</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 year</td>
<td>0.63%</td>
<td>5</td>
</tr>
<tr>
<td>2 - 3 years</td>
<td>4.25%</td>
<td>34</td>
</tr>
<tr>
<td>3 - 4 years</td>
<td>2.38%</td>
<td>19</td>
</tr>
<tr>
<td>4 - 10 years</td>
<td>8.63%</td>
<td>69</td>
</tr>
<tr>
<td>10 - 20 years</td>
<td>20.38%</td>
<td>163</td>
</tr>
<tr>
<td>&gt;20 years</td>
<td>63.75%</td>
<td>510</td>
</tr>
</tbody>
</table>

**Export Graph**

Total # of respondents 877. Statistics based on 800 respondents; 0 Filtered; 77 skipped.

### What is your main reason for driving?

<table>
<thead>
<tr>
<th>Reason</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To work</td>
<td>36.25%</td>
<td>290</td>
</tr>
<tr>
<td>To school</td>
<td>2.88%</td>
<td>23</td>
</tr>
<tr>
<td>Weekend driving</td>
<td>14.63%</td>
<td>117</td>
</tr>
<tr>
<td>Leisure</td>
<td>7.75%</td>
<td>62</td>
</tr>
<tr>
<td>Run errands</td>
<td>19.25%</td>
<td>154</td>
</tr>
<tr>
<td>Family purpose</td>
<td>12%</td>
<td>96</td>
</tr>
<tr>
<td>Other</td>
<td>7.25%</td>
<td>58</td>
</tr>
</tbody>
</table>

**Export Graph**

Total # of respondents 877. Statistics based on 800 respondents; 0 Filtered; 77 skipped.

### What is your general reaction when cyclists interfere with your driving?

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow down</td>
<td>8.5%</td>
<td>68</td>
</tr>
<tr>
<td>Overtake cyclist(s)</td>
<td>2.75%</td>
<td>22</td>
</tr>
<tr>
<td>Stop</td>
<td>0.25%</td>
<td>2</td>
</tr>
<tr>
<td>Make a lane change if possible</td>
<td>11.88%</td>
<td>95</td>
</tr>
<tr>
<td>Slow down and overtake where safe</td>
<td>73.63%</td>
<td>589</td>
</tr>
<tr>
<td>Other</td>
<td>3%</td>
<td>24</td>
</tr>
</tbody>
</table>

**Export Graph**

Total # of respondents 877. Statistics based on 800 respondents; 0 Filtered; 77 skipped.
- Are you aware of the following NSW RTA guideline on overtaking?
  "If you are overtaking a bicycle rider, give them at least 1 metre of space to the side in a 50km/h zone. If the speed limit is higher, you need to give the cyclist more space."

<table>
<thead>
<tr>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>16.63%</td>
<td>133</td>
</tr>
<tr>
<td>Yes</td>
<td>49.88%</td>
<td>399</td>
</tr>
<tr>
<td>Yes, but not the exact</td>
<td>33.5%</td>
<td>268</td>
</tr>
<tr>
<td>details</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 800 respondents; 0 filtered; 77 skipped.

- As a driver, when you are overtaking a bicycle, how important do you think it is for a car to provide overtaking distance?

<table>
<thead>
<tr>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Important</td>
<td>88.13%</td>
<td>705</td>
</tr>
<tr>
<td>Important</td>
<td>10.63%</td>
<td>85</td>
</tr>
<tr>
<td>Neutral</td>
<td>0.88%</td>
<td>7</td>
</tr>
<tr>
<td>Unimportant</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Highly Unimportant</td>
<td>0.38%</td>
<td>2</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 800 respondents; 0 filtered; 72 skipped.

- Are you aware of the fact that countries such as the US and some European countries (Belgium, France etc.) have legalized a specified "Minimum Overtaking Distance"?

<table>
<thead>
<tr>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>51%</td>
<td>408</td>
</tr>
<tr>
<td>No</td>
<td>49%</td>
<td>392</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 800 respondents; 0 filtered; 77 skipped.

- Do you agree that there is a need to develop a safer cycling environment?

<table>
<thead>
<tr>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>87.25%</td>
<td>698</td>
</tr>
<tr>
<td>Agree</td>
<td>9.75%</td>
<td>78</td>
</tr>
<tr>
<td>I don't know</td>
<td>2.25%</td>
<td>18</td>
</tr>
<tr>
<td>Disagree</td>
<td>0.5%</td>
<td>4</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>0.25%</td>
<td>2</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 800 respondents; 0 filtered; 77 skipped.
1. Please suggest ways that the cycling environment can be improved.

<table>
<thead>
<tr>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>775</td>
</tr>
</tbody>
</table>

2. Do you think a specified 'Minimum Overtaking Distance' should be legalized?

<table>
<thead>
<tr>
<th>Response</th>
<th>Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>82.75%</td>
<td>662</td>
</tr>
<tr>
<td>No</td>
<td>5.88%</td>
<td>47</td>
</tr>
<tr>
<td>Unsure</td>
<td>11.38%</td>
<td>91</td>
</tr>
</tbody>
</table>

3. How far do you think the 'Minimum Overtaking Distance' should be?

<table>
<thead>
<tr>
<th>Distance</th>
<th>Response Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 m</td>
<td>1.75%</td>
<td>14</td>
</tr>
<tr>
<td>1.0 m</td>
<td>57.75%</td>
<td>462</td>
</tr>
<tr>
<td>1.5 m</td>
<td>33.13%</td>
<td>265</td>
</tr>
<tr>
<td>2.0 m</td>
<td>7.38%</td>
<td>59</td>
</tr>
</tbody>
</table>

4. As a driver, how difficult is it to control a specified overtaking distance when passing bicycles?

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Response Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>28%</td>
<td>224</td>
</tr>
<tr>
<td>Possible</td>
<td>39.63%</td>
<td>317</td>
</tr>
<tr>
<td>Difficult</td>
<td>12.5%</td>
<td>100</td>
</tr>
<tr>
<td>Very difficult</td>
<td>2.63%</td>
<td>21</td>
</tr>
<tr>
<td>I have never had difficulty</td>
<td>17.25%</td>
<td>138</td>
</tr>
<tr>
<td>Issue</td>
<td>Response percent</td>
<td>Response total</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Weather</td>
<td>8.25%</td>
<td>66</td>
</tr>
<tr>
<td>Distance of cyclist(s) from kerb</td>
<td>32.13%</td>
<td>257</td>
</tr>
<tr>
<td>Cyclists’ cycling behaviour</td>
<td>32.25%</td>
<td>258</td>
</tr>
<tr>
<td>Width of road</td>
<td>73.75%</td>
<td>599</td>
</tr>
<tr>
<td>Limited visibility</td>
<td>20.5%</td>
<td>164</td>
</tr>
<tr>
<td>Parked cars</td>
<td>46.75%</td>
<td>374</td>
</tr>
<tr>
<td>Oncoming vehicles</td>
<td>58.88%</td>
<td>471</td>
</tr>
<tr>
<td>Congestion</td>
<td>31%</td>
<td>248</td>
</tr>
<tr>
<td>Terrain</td>
<td>9.5%</td>
<td>76</td>
</tr>
<tr>
<td>Speed of car(s)</td>
<td>15.5%</td>
<td>124</td>
</tr>
<tr>
<td>Slow speed of bicycle(s)</td>
<td>10.13%</td>
<td>81</td>
</tr>
<tr>
<td>Others</td>
<td>13.63%</td>
<td>109</td>
</tr>
</tbody>
</table>

**Export Graph**
Total # of respondents 877. Statistics based on 800 respondents; 0 filtered; 77 skipped.

**Do you ever feel that cyclists’ safety is at risk when you are overtaking them?**

<table>
<thead>
<tr>
<th>Response</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>14.88%</td>
<td>119</td>
</tr>
<tr>
<td>Sometimes</td>
<td>43.75%</td>
<td>350</td>
</tr>
<tr>
<td>Never</td>
<td>41.38%</td>
<td>331</td>
</tr>
</tbody>
</table>

**Export Graph**
Total # of respondents 877. Statistics based on 800 respondents; 0 filtered; 77 skipped.

**Were you ever involved in an accident that was caused by overtaking a cyclist?**

<table>
<thead>
<tr>
<th>Response</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>1.88%</td>
<td>15</td>
</tr>
<tr>
<td>No</td>
<td>98.13%</td>
<td>785</td>
</tr>
</tbody>
</table>

**Export Graph**
Total # of respondents 877. Statistics based on 800 respondents; 0 filtered; 77 skipped.

**Was the accident majorly caused by the car or the bicycle?**

<table>
<thead>
<tr>
<th>Caused by</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>86.67%</td>
<td>13</td>
</tr>
<tr>
<td>Bicycle</td>
<td>13.33%</td>
<td>2</td>
</tr>
</tbody>
</table>

**Export Graph**
Total # of respondents 877. Statistics based on 15 respondents; 0 filtered; 862 skipped.

**Do you think the accident could have been avoided if there was a specified ‘Minimum Overtaking Distance’?**

<table>
<thead>
<tr>
<th>Response</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>46.67%</td>
<td>7</td>
</tr>
<tr>
<td>No</td>
<td>26.67%</td>
<td>4</td>
</tr>
<tr>
<td>Uncertain</td>
<td>26.67%</td>
<td>4</td>
</tr>
</tbody>
</table>

**Export Graph**
Total # of respondents 877. Statistics based on 15 respondents; 0 filtered; 862 skipped.
Please kindly provide us with further details of your personal experiences.

1c. What are some of the circumstances, which can induce potential accidents between cars and cyclists?

We do appreciate detail descriptions of your personal experiences, such as weather, visibility, lighting, clothing of the cyclist etc.

<table>
<thead>
<tr>
<th>Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>633</td>
</tr>
</tbody>
</table>

Total # of respondents 877. Statistics based on 633 respondents; 0 filtered; 244 skipped.

This study will be correlated with a 15 minutes computer driving simulation. This driving simulation program will take place in January 2015. Please kindly fill in your email address if you would like a chance to participate in this simulation program.

<table>
<thead>
<tr>
<th>I will not participate</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>54.65%</td>
<td>435</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yes, I would like to participate. Email:</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45.35%</td>
<td>361</td>
</tr>
</tbody>
</table>

Total # of respondents 877. Statistics based on 796 respondents; 0 filtered; 81 skipped.

*This study will be correlated with a 15 minutes computer driving simulation. This driving simulation program will take place in January 2015. Please kindly fill in your email address if you would like a chance to participate in this driving simulation.*
### How many years of on road cycling experience do you have?

<table>
<thead>
<tr>
<th>Experience</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2 years</td>
<td>10.15%</td>
<td>77</td>
</tr>
<tr>
<td>2 - 5 years</td>
<td>19.63%</td>
<td>149</td>
</tr>
<tr>
<td>6 - 10 years</td>
<td>16.47%</td>
<td>125</td>
</tr>
<tr>
<td>11 - 15 years</td>
<td>8.3%</td>
<td>63</td>
</tr>
<tr>
<td>&gt;15 years</td>
<td>45.46%</td>
<td>345</td>
</tr>
</tbody>
</table>

**Total # of respondents 877. Statistics based on 759 respondents; 0 filtered; 118 skipped.**

### How many days per week do you cycle?

<table>
<thead>
<tr>
<th>Days per week</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day/week</td>
<td>12.25%</td>
<td>93</td>
</tr>
<tr>
<td>2-3 days/week</td>
<td>26.48%</td>
<td>201</td>
</tr>
<tr>
<td>3-5 days/week</td>
<td>42.03%</td>
<td>319</td>
</tr>
<tr>
<td>6-7 days/week</td>
<td>19.24%</td>
<td>146</td>
</tr>
</tbody>
</table>

**Total # of respondents 877. Statistics based on 759 respondents; 0 filtered; 118 skipped.**

### What is your main reason(s) for cycling?

**You may select more than one response**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To work</td>
<td>49.8%</td>
<td>378</td>
</tr>
<tr>
<td>To school</td>
<td>6.19%</td>
<td>47</td>
</tr>
<tr>
<td>Weekend cycling</td>
<td>45.59%</td>
<td>346</td>
</tr>
<tr>
<td>Mountain cyclist</td>
<td>13.83%</td>
<td>105</td>
</tr>
<tr>
<td>Recreational</td>
<td>61.92%</td>
<td>470</td>
</tr>
<tr>
<td>Run errands</td>
<td>24.24%</td>
<td>184</td>
</tr>
<tr>
<td>Member of cycling club(s)</td>
<td>26.09%</td>
<td>198</td>
</tr>
<tr>
<td>Group rides</td>
<td>29.78%</td>
<td>226</td>
</tr>
<tr>
<td>Other</td>
<td>12.78%</td>
<td>97</td>
</tr>
</tbody>
</table>

**Total # of respondents 877. Statistics based on 759 respondents; 0 filtered; 118 skipped.**
As a cyclist, when a car is overtaking bicycle(s), how important do you think a 'Minimum Overtaking Distance' is?

<table>
<thead>
<tr>
<th>Importance</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Important</td>
<td>90.91%</td>
<td>690</td>
</tr>
<tr>
<td>Important</td>
<td>7.77%</td>
<td>59</td>
</tr>
<tr>
<td>Neutral</td>
<td>1.19%</td>
<td>9</td>
</tr>
<tr>
<td>Unimportant</td>
<td>0.13%</td>
<td>1</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 759 respondents; 0 filtered; 118 skipped.

Are you aware of the fact that countries such as the US and some European countries (Belgium, France etc.) have legalized a specified 'Minimum Overtaking Distance'?

<table>
<thead>
<tr>
<th>Awareness</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>59.46%</td>
<td>44</td>
</tr>
<tr>
<td>No</td>
<td>40.54%</td>
<td>30</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 744 respondents; 0 filtered; 133 skipped.

As a cyclist, how well do you think drivers control their overtaking distance when passing you?

<table>
<thead>
<tr>
<th>Control Level</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>0.66%</td>
<td>5</td>
</tr>
<tr>
<td>Good</td>
<td>15.02%</td>
<td>114</td>
</tr>
<tr>
<td>Fair</td>
<td>44.93%</td>
<td>341</td>
</tr>
<tr>
<td>Poor</td>
<td>29.91%</td>
<td>227</td>
</tr>
<tr>
<td>Extremely poor</td>
<td>9.49%</td>
<td>72</td>
</tr>
</tbody>
</table>

Export Graph
Total # of respondents 877. Statistics based on 759 respondents; 0 filtered; 118 skipped.
What are the particular group(s) of drivers that tend to have more dangerous driving habits?

<table>
<thead>
<tr>
<th>Group</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxi drivers, truck drivers etc.</td>
<td>299</td>
</tr>
</tbody>
</table>

Do you ever feel that your safety is at risk when cars are overtaking you?

<table>
<thead>
<tr>
<th>Perception</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>18.05%</td>
<td>137</td>
</tr>
<tr>
<td>Sometimes</td>
<td>81.03%</td>
<td>615</td>
</tr>
<tr>
<td>Never</td>
<td>0.92%</td>
<td>7</td>
</tr>
</tbody>
</table>

Do you agree that there is a need to develop a safer cycling environment?

<table>
<thead>
<tr>
<th>Agreement</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>78.38%</td>
<td>58</td>
</tr>
<tr>
<td>Agree</td>
<td>21.62%</td>
<td>16</td>
</tr>
<tr>
<td>I don't know</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Disagree</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

Please suggest ways that the cycling environment can be improved.

<table>
<thead>
<tr>
<th>Suggestion</th>
<th>Response total</th>
</tr>
</thead>
</table>

Which of the following issue(s) do you think have made it difficult for drivers to allow a sufficient overtaking distance when passing you?

<table>
<thead>
<tr>
<th>Issue</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather</td>
<td>13.51%</td>
<td>10</td>
</tr>
<tr>
<td>Distance of cyclist(s) from kerb</td>
<td>20.27%</td>
<td>15</td>
</tr>
<tr>
<td>Cyclist(s) cycling behaviour</td>
<td>16.22%</td>
<td>12</td>
</tr>
<tr>
<td>Width of road</td>
<td>66.22%</td>
<td>49</td>
</tr>
<tr>
<td>Limited visibility</td>
<td>17.57%</td>
<td>13</td>
</tr>
<tr>
<td>Parked cars</td>
<td>51.35%</td>
<td>38</td>
</tr>
<tr>
<td>Oncoming vehicles</td>
<td>44.6%</td>
<td>33</td>
</tr>
<tr>
<td>Congestion</td>
<td>37.84%</td>
<td>28</td>
</tr>
<tr>
<td>Terrain</td>
<td>10.81%</td>
<td>8</td>
</tr>
<tr>
<td>Speed of car(s)</td>
<td>37.84%</td>
<td>28</td>
</tr>
<tr>
<td>Speed of bicycle(s)</td>
<td>10.81%</td>
<td>8</td>
</tr>
<tr>
<td>Others</td>
<td>27.03%</td>
<td>20</td>
</tr>
</tbody>
</table>

Export Graph
<table>
<thead>
<tr>
<th>Question</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think a specified ‘Minimum Overtaking Distance’ should be legalized?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>90.54%</td>
<td>67</td>
</tr>
<tr>
<td>No</td>
<td>9.46%</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How far do you think a ‘Minimum Overtaking Distance’ should be?</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 m</td>
<td>1.35%</td>
<td>1</td>
</tr>
<tr>
<td>1.0 m</td>
<td>55.41%</td>
<td>41</td>
</tr>
<tr>
<td>1.5 m</td>
<td>36.49%</td>
<td>27</td>
</tr>
<tr>
<td>2.0 m</td>
<td>6.76%</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Were you ever involved in an accident that was caused by vehicle(s) overtaking cyclist(s)?</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>9.46%</td>
<td>7</td>
</tr>
<tr>
<td>No</td>
<td>90.54%</td>
<td>67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Was the accident majorly caused by the car or the bicycle?</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>100%</td>
<td>7</td>
</tr>
<tr>
<td>Bicycle</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Do you think the accident could have been avoided if there was a specified ‘Minimum Overtaking Distance’?</th>
<th>Response percent</th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>57.14%</td>
<td>4</td>
</tr>
<tr>
<td>No</td>
<td>28.57%</td>
<td>2</td>
</tr>
<tr>
<td>Uncertain</td>
<td>14.29%</td>
<td>1</td>
</tr>
</tbody>
</table>

Please kindly provide us with further details of your personal experiences.

ie. What are some of the circumstances, which induced potential accidents between cars and bicycles?
We do appreciate detailed descriptions of your experiences, such as weather, visibility, lightning, location etc.

<table>
<thead>
<tr>
<th></th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>57</td>
</tr>
</tbody>
</table>

Please kindly fill in your email address below for the chance to win 1 of 8 MyBus1 Travel 10 concession ticket.

<table>
<thead>
<tr>
<th></th>
<th>Response total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>612</td>
</tr>
</tbody>
</table>
10. Appendix C

Remarks: For simulation files please access DVD: Overtaking Cyclist Road Safety Simulation