School of Public Health

Road crash and injury of bus and taxi drivers in Hanoi, Vietnam

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature:

Date: 04th November, 2011

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Abstract

Injury due to road traffic crash is a major cause of ill health and premature death in developing countries for adult men aged 15-44 years. Previous studies have focused on different road user groups, such as pedestrians, bicyclists, motorcyclists and motor vehicle drivers. There is relatively little research examining the risk of crashes for bus and taxi drivers, particularly in developing countries. This study aims to profile the crash characteristics among bus and taxi drivers, and to investigate the risk factors for road traffic crash in Hanoi, Vietnam.

The study consisted of two phases. In the first phase, a retrospective study was undertaken to estimate the prevalence of road traffic crashes (RTCs) by bus and taxi drivers over the past three years (from 2006 to 2009), and to collect baseline information on their crash characteristics. The behaviour and lifestyle of 1579 drivers (365 bus and 1214 taxi drivers) in Hanoi were documented. During the second phase, the identified cohorts were followed up for 12 months. The objective of the prospective study was to assess the incidence of road traffic crash and the underlying exposure, type and severity of injuries, so that pertinent risk factors of road traffic crash for these drivers can be identified.

The study subjects consisted of 365 bus drivers and 1214 taxi drivers in Hanoi, Vietnam. Face-to-face interviews were conducted by the author and research team using a structured questionnaire to: collect information on demographic and lifestyle characteristics; record the history of road traffic crash for a period of three years (2006 to 2009) and detail crash characteristics during a 12 month follow up (2009 to 2010).

The main findings of the first phase of study involving 1214 taxi drivers showed that the mean age of drivers was 31.9 (Standard Deviation (SD) = 6.8) years. The mean working years as taxi drivers was 2.59 (SD: 2.3) years, with the longest duration being 15 years and shortest being two months. The travelling distance of each driver ranged from 80 kilometres to 350 kilometres, with a mean of 182.2 (SD: 48.5) kilometres per working day. The percentage of drivers who were smokers was 54.4%, and 60.7% of drivers had not consumed alcohol within the last month.

A total of 276 taxi drivers were involved in 336 RTCs with a prevalence of 27.7% for a period of three years. Ninety three (27.7%) crashes resulted in hospitalization. Results of logistic regression analysis found that the age of drivers (Odd Ratio (OR) = 0.95, 95% Confidence Interval (CI): 0.92 to 0.97), type of driving license (OR = 1.56; 95% CI: 1.17 to 2.09), full-time employment status (OR = 2.22; 95% CI: 1.09 to 4.54), insufficient income (OR = 1.44; 95% CI: 1.08 to 1.93), never wore a seat-belt (OR = 1.69; 95% CI: 1.04 to 2.44), and traffic infringement history (OR = 1.87; 95% CI: 1.30 to 2.71), were significantly associated with RTCs.

After the 12 month follow up, 225 (18.5%) of 1214 taxi drivers had dropped out due to change of job and/or lack of follow up contact details. The 11.9% of drivers (145 drivers) have been involved in at least one RTC within 12 months. Among these 145 drivers, only three drivers reported to involve in two crashes. Cumulative Incidence rate was 0.122 in 12 months.

The crashes between taxi drivers and motorcyclists accounted for 59.5% of crashes. A high percentage of crashes (89.9%) occurred on street roads and 10.1% on the highway. Crash incident on straight and level roads was 71.6%. Crashes in dry conditions accounted for 75.7%, with 62.2% of crashes happened in daylight. Of 148 crashes, 39.9% had at least one hospitalised person (accounted for either drivers or other crash victims), with 8.1% of crashes accounting for two hospitalised persons. The results of logistic regression analysis in the follow up period indicated that only suffered from tiredness increased the risk of RTC for taxi drivers. The risk of hospitalisation as the outcome of crash led to identification of three significant factors, namely: crashes happened in rush hours (OR = 2.24, 95% CI: 1.00 to 5.03), crashes between taxi and motorbike (OR = 7.28; 95% CI: 2.87 to 18.42), and crashes happened in curve or hillcrest roads (OR = 2.68; 95% CI: 1.00 to 6.80).

The 365 bus drivers were all male and recruited from five bus companies in Hanoi. Three quarters of the bus drivers were less than 45 years old. The mean age of the bus drivers was 39.2 (SD: 7.2) years old. The mean working years as bus drivers was 6.77 (SD: 4.6) years. The percentage of drivers who were in full-time employment was 75.6%. The average travel distance of each driver was 175.1 (SD: 37.2) kilometres per working day.

More than 50% of bus drivers were smokers. Among smoking drivers, 6.1% smoked more than 20 cigarettes per day. Drivers who had drunk at least one standard drink in the last month accounted for 68.8% of all drivers and 66.0% of drivers had made a phone call when driving a bus. Only 10.2% of bus drivers always wore a seat-belt.

In the last three years, 73 bus drivers involved in 76 RTCs. The RTC prevalence was 20.8%, with 73.7% of crashes resulting in hospitalisation. Among these 73 drivers, three (4.2%) drivers were involved in two crashes during the last three years. Crashes mainly occurred on local streets/roads (80.9%).

Logistic regression analysis to explore the contributing factors of RTC resulted in two significant factors namely: migrant worker (OR = 4.26; 95% CI: 2.20 to 8.25) and insufficient income (OR = 2.6; 95% CI: 1.37 to 4.93). The results of Poisson regression between the number of crashes and other variables indicated two contributing factors. They were type of worker (Incidence-Rate Ratio (IRR) = 2.89; 95% CI: 1.67 to 4.98), and adequacy of income (IRR = 1.73; 95% CI: 1.03 to 2.94). The migrant workers were likely to be involved in more RTCs than others, and drivers who reported earning insufficient money for their family were also likely to be involved in more RTCs compared to others drivers.

Within 12 month follow up of 365 bus drivers, there were 39 (10.7%) drivers in loss to follow up condition. A total of 109 drivers have ever involved in at least one RTC in this follow up duration. Among the crash drivers, 96.4% were involved in one crash. Cumulative Incidence rate of RTC of this cohort of bus drivers in 12 months was 0.304.

Up to 13.5% of crashes happened during rush hour (from 6 AM to 8 AM and from 5 PM to 6 PM). Crashes where there was a collision between buses and motorbikes accounted for 53.5%, and 3.6% between buses and pedestrians or passengers, and 93.7% of crashes occurred in the local street/road areas, as opposed to only 0.9% on the highway. With regard to the gradient of the road, 47.7% of crashes were in straight and level roads, 30.6% in curved and grade/hillcrest roads, and 11.7% in curved and level roads. Crashes occurring during daylight accounted for 65.8% with 68.5% in dry conditions, and 54.1% in crowded road conditions.

Results of logistic regression of RTC during follow up time indicated two statistically significant factors; they were migrant drivers and insufficient income

drivers. Results of logistic regression, for risk factors of severity of crash indicated two significant factors, which were types of vehicles/objects of crash, and weather condition at the time of crash. Crashes happening due to bus and motorbike collision were more likely to result in a person being hospitalised, than other subjects involved in collision (OR = 6.65; 95% CI: 2.20 to 20.16). Crashes in wet weather were more likely to result in a hospitalised person (OR = 3.36; 95% CI: 1.11 to 10.10).

There are some limitations that need to be considered when interpreting the findings of the study. For the retrospective study, prevalence of RTCs did not include bus and taxi drivers, who left the profession prior to the survey because of crashes or other reasons. The possibility of recall bias based on self-reports was another issue. For the prospective study, new drivers who entered the profession were excluded in the follow up. Moreover, in the 12 month follow up, tracking the cohorts and loss to follow up posed a difficulty for interpreting the results.

The main recommendation of the study was the need to conduct a qualitative survey to identify the root causes and perceptions of bus and taxi drivers in relation to the RTCs. Physical health outcomes may mediate the relationship between stress and crash outcomes. Studies on physical health of drivers and its association with crashes are needed. Their working conditions should be further explored in relation to the level of workload, and extra work to provide them with sufficient income. Moreover, it is recommended to investigate RTCs of bus and taxi drivers from the perspective of other road users. An intervention should then be implemented to improve the safety of these drivers.

Abbreviations

ABS	Anti-lock Braking System
AM	Ante Meridiem (being before noon)
CI	Confidence Interval
GDP	Gross Domestic Product
GNP	Gross National Product
IRR	Incidence-Rate Ratio
MOH	Ministry of Health
NTSC	National Traffic Safety Committee
OR	Odds Ratio
PM	Post Meridiem (being after noon)
RTC	Road Traffic Crash
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
UNICEF	United Nations Children Fund
USA	United States of America
VND	Vietnam Dong (local currency of Vietnam)
WHO	World Health Organization

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Chapter 1: Introduction

Overview

This chapter presents the rational for the study by describing the burden of RTCs from a global perspective and within a Vietnamese context. The main risk factors of RTCs in particular those associated with buses and taxis are presented. The significance and objectives of the study are also presented.

1.1. Burden of Road Traffic Crash

At a global level, RTCs are the largest cause of ill health and premature death, and the second largest cause of death in developing countries for adult males aged 15-44 years. An estimated 1.2 million people are killed in road crashes and about 50 million are injured each year (Peden M. et al., 2004). Projections indicate that these figures will increase by about 65% over the next 20 years, unless there is a greater commitment to prevention strategies (Peden M., et al., 2004; Sharma, 2008).

Previous studies showed that, while road deaths are slowly decreasing in developed countries, in developing countries they are increasing (Ameratunga, Jackson, & Norton, 2006; Wiebe, Nance, & Branas, 2006). About 85% of road traffic injuries and deaths occur in developing countries, where vehicle ownership levels are low by comparison with western standards, and a considerable investment is being made to improve road infrastructure (Peden M., et al., 2004; Howe, Huttly, & Abramsky, 2006). If no major action is taken, road traffic deaths are projected to increase by 83% in low-income and middle income countries (Mohan, Tiwari, Khayesi, & Nafukho, 2006).

The patterns of RTCs are different between developing and developed countries. Road crashes may be due to mixed modes of transport. For instance, the ratio of bicycles and motorcycles to cars in developing countries is much higher (Barss, Smith, Baker, & Mohan, 1998). In New Delhi, India, 77% of the victims of motor vehicle crashes were attributed to unprotected road users, and 58% of cases were the victims of bus or truck crashes (Barss, et al., 1998). In Thailand, bus crashes are a major public concern (Taneerananon & Somchainuek, 2005).

In Vietnam, a market economy ("Doi Moi") was introduced in 1986, leading to a rapid increase in development in the country. Motorization has increased dramatically in Vietnam during the past 10 years, along with economic and social development. Ownership of cars has increased at an annual average rate of 12%, while motorcycles have increased at an average rate of 40% per year. This has resulted in a 16.5 fold ratio between 2-wheel and 4-wheel motor vehicles. Currently, there are about 19.2 million registered cars and motorbikes, of which 5% are cars (Phong, 2010). During the past 10 years, the number of road crashes has increased four-fold. The National Transportation Safety Committee (2008) reported that the national mortality rate due to traffic crashes is about 11 deaths per 10,000 motor vehicles, which is similar to other Southeast Asian countries. However, there have been average annual increases of 38% in traffic injuries, 52% in the number of injured, as well as 37% in the number of deaths (Thai, 2008).

Road crashes occur more frequently in urban areas than rural areas of Vietnam (Thai, 2006; Phong, 2010), even though rural crashes tend to be more severe. The National Transportation Safety Committee estimated that the cost of road crashes in Vietnam is at least 2% of the gross domestic product (Thai, 2006; Phong, 2010). More than 12,000 people die per year because of road crashes, the majority (73.4%) involve motorcycles (Phong, 2010). However, serious injuries are often associated with car crashes (Preventive Medicine Department, 2006b; Phong, 2010). In the cities, car crashes often involve small cars and public transport vehicles, namely, buses and taxis (Anh, Anh, & Dao, 2005). Recently, many newspaper articles have reported on the popularity, severity, and the increasing number of crashes caused by buses and taxis. Currently the leadership of Vietnamese' Government have shown their concern on this issue, through the National strategy on public transportation for big cities in Vietnam, which involves the development of a safe bus and taxi system (Vietnamese' Government, 2009). The strategy of Vietnamese Government (2009) indicates an increase in number of buses to 77 routes and number of bus passengers to 700 million per year by 2015.

1.2. Risk Factors of Road Traffic Crash

RTCs are related to a combination of factors such as road conditions, the environment, vehicle characteristics, the attitudes and behaviour of road users (Degutis & Greve, 2006). Identifying and quantifying risk factors of RTCs are

important for promoting the development of strategies and interventions for reducing the risk of crashes (Mohan, et al., 2006). In developing countries, potential risk factors include age and gender of drivers, road infrastructure, insufficient knowledge of traffic rules, dangerous parking, as well as drug and alcohol consumption (Hakkert, Gitelman, Cohen, Doveh, & Umansky, 2001; Javouhey, Guerin, & Chiron, 2006).

In terms of age, young drivers (aged less than 20 years) pose the greatest risk to passengers and other road users. On the other hand, old drivers have more serious collisions, with two-thirds of the deaths due to crashes involving drivers above 75 years (Braver & Trempel, 2004; Nguyen, Nguyen, Nguyen, & Duong, 2005). With respect to gender and motor vehicle crashes, the highest fatality rate occurred amongst males in the 15-24 age group (Cryer, Davidson, Styles, & Langley, 1996).

A study in Hawaii, on the attitudes of commercial drivers towards safety seat-belt in 2006, found that a higher proportion of females (87.7%) always used seat-belt compared to males (64.6%), whereas older commercial drivers (72.7%) were more likely to wear seat-belt than younger drivers (60.5%) (Kim & Yamashita, 2007).

For taxi drivers, gender, night-time driving, and the presence of passengers are significantly associated with an increased risk of crashes in New South Wales. The relative risk of a road crash is increased by 60% for taxi drivers who work at night and by 20% for those who are not carrying any passengers. The risk of a road crash among female taxi drivers is nearly 2.5 times higher than their male counterparts (Lam, 2004).

A study on the characteristics and causes of bus crashes in Thailand, reported that during the period from 1997 to 2000, 3,000 bus crashes occurred on highways resulting in about 1,500 deaths. More than half of these crashes were single bus crashes involving roll-overs. Excess speed was the main contributing factor responsible for 72% of crashes (Taneerananon & Somchainuek, 2005).

Another study in Ghana showed that the majority (58%) of motor vehicle crashes occurring in urban areas, involved buses and mini-buses, while a relatively smaller proportion (10%) of crashes involved taxis. The rest were due to motorbikes, trucks and private cars (Mock, Forjuoh, & Rivara, 1999).

There are a number of potential risk factors for bus and taxi crashes. These include exceeding speed limits, abrupt cutting-in (Ameratunga, et al., 2006), improper overtaking, failure to indicate intentions (Mock, et al., 1999; Broyles, Narine, Clarke, & Baker, 2003), disregarding traffic signals, signs or markings, as well as ignoring stop signs at an intersection (Javouhey, et al., 2006).

In Vietnam, speeding (34%) and passing illegally (22%) are mostly responsible for road crashes, whereas poor awareness about traffic safety is the main cause of injury for all kinds of transport (Anh, et al., 2005). According to the Hanoi Transport Corporation (2008), there were about 60 crashes among the 600 buses in Hanoi in 2006. The main reasons for the crashes were driver fatigue, new drivers unfamiliar with the routes, and congested roads (Đoàn, 2006).

Recently, road crashes involving buses and taxis have been extensively covered by newspapers in Hanoi. The causes responsible for these crashes included brake system problems (Dũng, 2003), behaviour of the bus driver assistant (Tuoi Tre news, 2006), unsafe practices such as overturning, failing to wear seat-belts, and poor vehicle maintenance (Hoang, 2007; Minh, 2007). Some newspaper reports also mentioned the stressful work schedule of bus and taxi drivers (Đoàn, 2006; Mạnh, 2007; Tùng, 2007). To increase profit margins, owners of public transport companies often demand their drivers to work long hours and to drive even when exhausted (Đoàn, 2006; Mohan, et al., 2006).

1.3. Significance of the Study

Because of rapid economic development coupled with the rising population, the trends of motor vehicle usage and consequently road injury are changing. For example, in Shenzhen, China, the increase of motor vehicles was almost five-fold over the 10-year period 1989-1999 (Gan, 2003). Although motorcycles have provided a convenient and cheap means of transport during the past decade in Vietnam, cars are becoming more popular in the cities due to the increase in living standards. Along with the problems associated with the increase in motor vehicles, road crashes and injuries have emerged as major concerns for the Vietnamese government. Being the capital city and with a population of 3.2 million (General Statistic Office, 2007), Hanoi is the centre of economic development in North

Vietnam. Currently, buses and taxis provide the main modes of public transport in Hanoi, while trains and trams remain limited or unavailable.

This study will provide reliable and useful information on bus and taxi crashes, and the type and severity of injuries for bus and taxi drivers in Hanoi. Detailed characteristics of crashes and issues concerning these two groups of professional drivers will be identified and assessed in detail.

Whilst most studies in developing countries focused on bicyclists, motorcyclists and pedestrians, relatively little attention has been paid to bus and taxi drivers. By determining relevant and modifiable risk factors, the findings of this study will enable the development of effective strategies and interventions targeting bus and taxi drivers. For example, programs to control and manage their harmful habits and unsafe driving practices have the potential to improve their health and safety as well as that of other road users. This research is particularly important and timely, as bus and taxis will continue to be the main modes of public transport in the foreseeable future to deal with the rising population and the rapid economic growth in the capital of Vietnam.

1.4. Aim and Objectives of Study

1.4.1. Aim

- To investigate the morbidity (prevalence and incidence) and risk factors of road traffic crashes and severity of crash among bus and taxi drivers in Hanoi, Vietnam.
- To suggest road safety strategies to reduce road traffic crashes and crash related injuries among bus and taxi drivers in Hanoi, Vietnam.

1.4.2. Objectives of Study

Phase 1: Retrospective study

1. To estimate the prevalence of road traffic crashes by bus and taxi drivers for the last three years, from 2006 to 2009.

Phase 2: Prospective study

2. To assess the incidence of road crashes, underlying exposures, type and severity of crashes during the 12 month follow up period for the cohort of bus and taxi drivers identified from the first phase of study.
3. To identify the pertinent risk factors affecting the severity of road traffic crashes for bus and taxi drivers.
4. To suggest recommendations to improve the safety of buses and taxis in Hanoi, Vietnam.

1.5. Outline of the Thesis

The thesis consists of basic requirement components as Abstract, Introduction, Review of Literature, Research Methodology, Results, Discussions, Conclusions and Recommendations, and other supplementary parts of dissertation.

In the Abstract, the main reason for conducting the study, principle objectives, key points of study design and the results, recommendations of study are presented, in order to give the readers key ideas and findings of the study.

Chapter one provides a brief introduction of the morbidity, mortality, and burden of road traffic injury, and documents the aim and specific objectives of the study. Chapter two reviews the literature on RTCs among motor vehicles, specifically for bus and taxi as commercial transport vehicles; the risk factors of RTCs related to bus and taxi drivers are also presented. Chapter three describes the methodology of the study, including the study design and location, recruitment of subjects, questionnaire and instruments used, interview and data collection procedure, and statistical analysis. Chapter four presents the detailed results of the study. Chapter five discusses the results in relation to the literature and a summary of the underlying limitations. Chapter six provides conclusions and recommendations based on the study findings. Additionally, information sheets, consent forms, questionnaires and other relevant documents are given in the Appendices.

Chapter 2: Review of Literature

Overview

This chapter presents a critical review of the literature and relevant studies in developed and developing countries related to RTC and injury among buses and taxis. This includes: (i) magnitude and impact of road crash and injury, (ii) risk factors for road crash and injury of bus and taxi drivers, and (iii) summary of findings and lesson learnt from bus and taxi studies.

Using a combination of search terms including “bus driver”, “taxi driver”, “traffic crashes”, and “professional drivers”, “commercial drivers”, several electronic databases (PubMed, ScienceDirect, Informit, Medline, ProQuest, and PsycInfo) were used. Articles that fulfilled the following criteria were considered: (i) sample included bus or taxi drivers, (ii) appeared in peer-reviewed psychological or medical journals and, (iii) published in English from 1990 onward.

2.1. Magnitude and Impact of Road Traffic Crash and Injury

2.1.1. Global Estimates

At a global level, road traffic crashes are the largest cause of ill health and premature death, and the second largest in developing countries for adult males aged 15-44 years. An estimated 1.2 million people are killed in RTCs and about 50 million are injured each year (Peden M., et al., 2004). The Asia and Pacific region contributes 44% of global road deaths (Asian Development Bank, 2004). There are notable differences in the way different road users are affected by road traffic crashes. More than half of all global road traffic deaths occur among young adults between 15 and 44 years of age. Seventy three percent of all global road traffic fatalities are males. Vulnerable road users – pedestrians, cyclists and motorcyclists – account for a much greater proportion of road traffic collisions in low income and middle income countries than in high income countries (Mohan, et al., 2006; Mohan, 2008).

Previous studies showed that, while road deaths are slowly decreasing in developed countries, developing countries face a worsening situation (Ameratunga, et al., 2006;

Wiebe, et al., 2006; Wesemann, Norden, & Stipdonk, 2010). According to the *World Report on Road Traffic Injury Prevention* (2004), about 85% of RTCs occur in developing countries, where vehicle ownership levels are low by western standards and where a considerable investment is being made to improve road infrastructure (Peden M., et al., 2004; Howe, et al., 2006). If no major action is taken, road traffic deaths are projected to increase by 83% in low income and middle income countries by 2020 (Mohan, et al., 2006).

Bus and taxi road traffic crashes

Information from the European Commission website (2008) show that unlike the trend for cars, deaths and injuries involving buses and coaches have been stable over recent years. Around 20,000 buses and coaches weighing over 5,000 kilograms are involved in RTCs, with around 35,000 people injured and 250 killed every year (European Commission, 2008).

A review of the European literature found that only 0.3–0.5% of all traffic fatalities were related to bus and coach fatalities. Fatalities were more frequent on rural roads, although a vast majority of all bus and coach casualties occurred on urban roads (Albertsson & Falkmer, 2005).

A study on the incidence and characteristics of school bus crashes and injuries in the USA found that school bus crashes were 320.7 per 100 million bus miles travelled (Yang et al., 2009). In this study, school bus crash fatality and injury rates were 3.5 and 5.4 times lower than overall all vehicle crash fatality and injury rates, respectively.

In Thailand, bus crashes are a major concern. In a 4 year-period (1997-2000), 3,000 bus crashes occurred on highways, resulting in approximately 1,500 deaths. In 2003, bus and taxis accounted for about 2.44% and 2.96% respectively among types of vehicles involved in RTCs in Thailand (Taneerananon & Somchainuek, 2005).

Bus crashes accounted for a disproportionate number of road traffic crash fatalities in a study in Karachi, Pakistan. Risky behaviour was considered common among Karachi bus drivers (Mirza, Mirza, Chotani, & Luby, 1999). In France, RTCs involving a bus or coach accounted for 1.5% of all personal injury traffic crashes, and the cause for 1.6% of traffic deaths and 1.8% of traffic injuries (Brenac & Clabaux, 2005).

A study on crashes undertaken in South Africa, found that the majority of drivers (64.6%) reported that they had never been involved in a crash whereas 33.8% had been involved in a taxi related crash (Peltzer & Renner, 2003). A study on taxis crashes in Quebec, Canada, found that taxi drivers had an average of 0.252 crashes per driver, per year (25 crashes for 100 taxi drivers), while the average rate for all drivers was approximately 0.07 crashes per year (Maag, Vanasse, Dionne, & Laberge-Nadeau, 1997). Information on taxi crashes in New York City found that of taxi passengers, who were involved in a crash, 21% were seriously injured or killed in 2004 (Schaller, 2006).

Another study in Ghana found that 58% of motor vehicle crashes occurring in urban areas involved buses and mini-buses, while a relatively smaller proportion (10%) of crashes involved taxis. The rest were due to motorbikes, trucks and private cars (Mock, et al., 1999).

In Vietnam, the rapid economic development and urbanization in recent years have created an increasing number of vehicles on the road. Consequently, the number of traffic injuries and mortality due to road traffic injury remains at a high level. Information on road traffic injury gained from the National Transportation Safety Committee (NTSC) of Vietnam found that over the past 10 years, the number of vehicles has increased from 5 million vehicles to 20 million vehicles, in which motorcycles make up a main proportion. Each year, there are about 15,000 road traffic crash cases, which cause RTC deaths to over 10,000 people (National Transportation Safety Committee of Vietnam, 2010). While the number of road traffic injury cases has decreased over the past 4 years, which has contributed to the reduction of persons injured, road traffic mortality has not decreased – on the contrary, it has increased (National Transportation Safety Committee of Vietnam, 2010).

2.1.2. Global Trends and Projections

Global trends and projections from the *World report on road traffic injury prevention in 2004* has indicated that the number of road traffic injuries and deaths occurring worldwide has continued to rise since the 1970s (Peden M., et al., 2004). There has been an overall downward trend in road traffic deaths in high income countries and an increase in low income and middle income countries. Road traffic injuries and

deaths are expected to increase by about 65% over the next 20 years, unless there is a greater commitment to prevention strategies (Peden M., et al., 2004). The report also projected that by 2020, road traffic injuries ranked 9th in 1990 will be ranked the 3rd overall (Peden M., et al., 2004). A report commissioned by World Health Organization on road safety, predicts that road crashes will become the fifth leading cause of death worldwide by 2030 (World Health Organization, 2009).

The results of a study in New York, USA in 2004 found that the number of taxi crashes involving injury has declined since 1999 (Schaller, 2006). There was a further decline from 13,126 in 1999 to 9,128 taxi crashes in New York City in 2004. The number of taxi crashes in 2004 was the lowest number in over a decade however the number of taxi crashes has increased in the range of 3,000 to 4,000 since 1996 (Schaller, 2006).

Southeast Asian nations

A study on RTCs in Thailand conducted by Taneerananon and Somchainuek (2005) found that the number of fatalities from road crashes in 2003 was 13,209, which was a significant reduction from the 1995 figure of 16,727. However, from 1997 to 2003, road traffic crashes has in Thailand have resulted in more than 142,630 deaths (Taneerananon & Somchainuek, 2005). According to the Asian Development Bank, if Southeast Asian nations do not start taking road safety seriously, there will be 385,000 road deaths and 24 million injuries in the next five years (Asian Development Bank, 2004).

2.1.3. Economic Impacts of Road Traffic Crashes

Apart from the burden of mortality, road traffic crashes has caused considerable economic costs to the community. Annually, about 1% of the gross national product (GNP) of low income countries, 1.5% of GNP in middle income countries, and 2% of GNP in high income countries are lost due to road traffic injury (Thanh, Hang, Chuc, & Lindholm, 2003; Sharma, 2008). It is estimated that for all Southeast Asian nations in the next five years, the cost of road traffic crashes will be more than 88 billion US dollars, which is a significant cost to the economy of these countries (Asian Development Bank, 2004).

A study conducted in Bangladesh by Mohan et al. (2006) reported that poor families were more likely to suffer immediate economic effects as a result of road traffic

injuries. Over 70% of households reported that their household income, food consumption and food production had decreased after a road death (Mohan, et al., 2006). In addition, 61% of poor families had to borrow money as a result of a death, compared with 34% of other families (Mohan, et al., 2006).

The percentage of GDP lost annually through road traffic crashes ranges from 0.5% in Singapore to 3.21% in Cambodia, and is averaging around 2.23% for the entire Southeast Asian region (Asian Development Bank, 2004). RTCs in Indonesia cost the economy approximately 6.03 billion US dollars per year (or 2.91% of annual GDP), followed by Thailand at 3 billion US dollars (2.1% of GDP) (Asian Development Bank, 2004). The study on the cost of RTCs in Vietnam, showed that the overall costs for the entire country, including property damage, medical cost, tangible and intangible costs, was about 628 million US dollars, approximately 1.41% of Vietnam GDP in 2004 (Anh, et al., 2005; Thai, 2008).

2.2. Risk Factors of Road Traffic Crash and Injury of Buses and Taxis

2.2.1. Conceptual Framework to Examine Risk Factors of Road Traffic Crash and Injury

Buses and taxis are among the main modes of public transportation, and are directly or indirectly involved in a large porportion of RTCs (Muhlrad & Lassarre, 2005). There is currently no specific framework for examining RTCs and injury related to bus and taxi crashes. The conceptual framework used in this study (Figure 2.1) to examine risk factors for a RTC and injury was modified and adapted from the book: *Systems approach to injury control* (Muhlrad & Lassarre, 2005). Determinants of RTC and injury were classified into three main categories: (i) human factors, (ii) road and environment factors, and (iii) vehicle factors.

An analysis of specific determinants for RTC and injury is an essential element of injury control (Barss, et al., 1998). Traditionally, analysis of risk factors for RTCs has examined the road user, vehicle and road environment separately. Furthermore, there is a tendency by researchers and practitioners to look for one or a few factors, when in actual fact they should be analysing multiple factors (Mohan, et al., 2006).

RTCs are due to a combination of factors such as road conditions, the environment, vehicles and the attitudes and behaviour of road users (Degutis & Greve, 2006). Identifying and quantifying risk factors for RTCs is important for the development of strategies and interventions for reducing the crash risk (Mohan, et al., 2006). In developing countries, potential risk factors for a RTC include age and gender of drivers, road infrastructure, insufficient knowledge of traffic rules, dangerous parking, as well as drug and alcohol consumption (Hakkert, et al., 2001; Javouhey, et al., 2006).

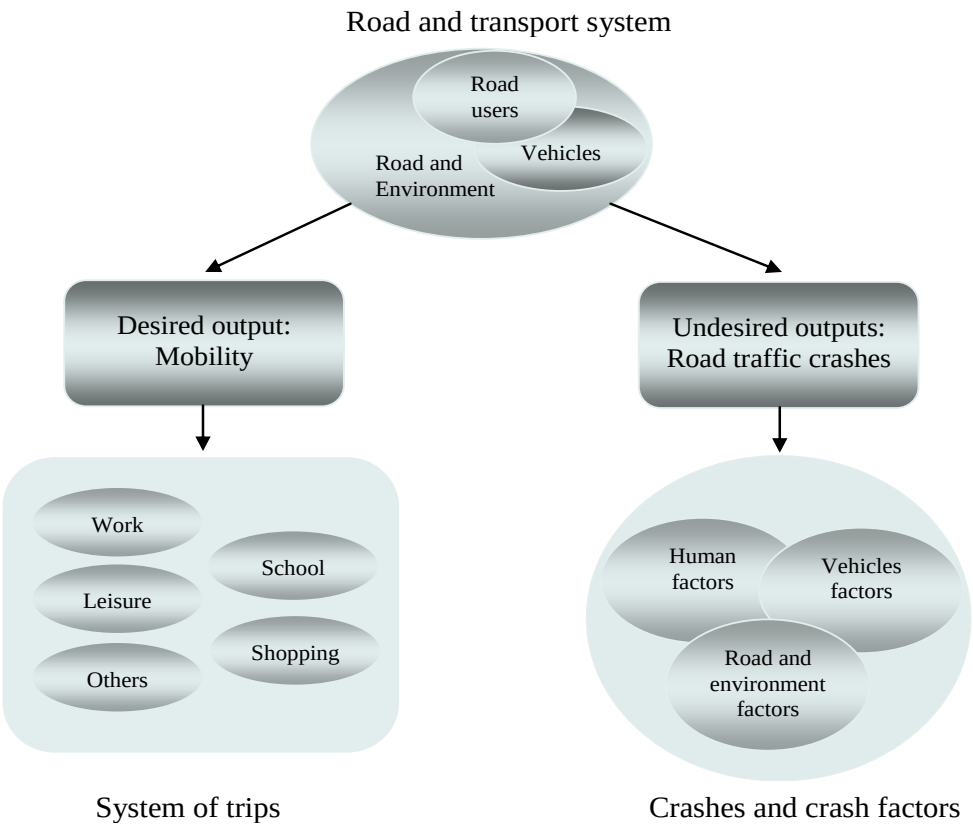

Figure 2.1: Risk factors framework of road traffic crash and injury

There are a number of risk factors for a RTC for bus and taxi drivers. Road user behaviours include exceeding speed limits, abrupt cutting-in (Ameratunga, et al., 2006), improper overtaking, failure to indicate intentions (Mock, et al., 1999; Broyles, et al., 2003), disregarding traffic signals, signs or markings, as well as ignoring stop signs at an intersection (Javouhey, et al., 2006). Detailed information on potential risk factors for RTCs in general and particular for buses and taxis are presented as follows.

2.2.2. Human Factors

2.2.2.1. Demographic factors

Age

There have been many studies focusing on the role of age in relation to RTC and injury. Among general motor vehicle drivers, in terms of age, novice and young drivers (aged less than 20 years) posed the greatest risk to their passengers and other road users. On the other hand, old drivers had more serious collisions, with two-third of the deaths in crashes involving older drivers above 75 years (Braver & Trempel, 2004; Nguyen, et al., 2005).

Information obtained from Police Traffic crash statistics in Hong Kong (1985) found that there was a dramatic decline in bus crashes with increasing age with the safest drivers being the oldest group, 58-60 years (Evans & Courtney, 1985). A study on bus crashes in Canada found that mean age of drivers at the time of a crash was 33.1 years. In addition, over 60% of drivers who had been involved in traffic crashes were under the age of 35 years (Hamed, Jaradat, & Easa, 1998).

A study on bus drivers and crash involvement in Sweden (af Wåhlberg, 2004b), found associations between crashes and some demographic and environmental factors. Hours worked were associated with crashes, as well as age (af Wåhlberg, 2004b).

A study on taxi driver crashes in Canada found that age was not associated with crash frequency but there was a consistent trend for the older age groups to be safer drivers (Maag, et al., 1997). A study on taxi drivers and road safety in Australia found that the distribution of crashes involving a taxi driver by age indicated differences between taxi drivers and the general public (Dalziel & Job, 1996). As the average age of taxi drivers in this study was 41 years, the highest percentage of crashes involving a taxi driver occurred in the age group, the 30-39 years. A study on factors associated with crash-related mortality and injury among taxi drivers in New South Wales, Australia found that half of the victims (52.6%) were aged between 25 and 44 years, with about 4% aged less than 25 years (Lam, 2004).

Gender

A Swedish study conducted in 2002, found that 86% of bus drivers were men, with male bus drivers more likely to be involved in a crash than female drivers (af Wåhlberg, 2004b). Another study on risky behaviour of bus drivers in Karachi, Pakistan, found difference in sex specific proportions in injured passengers. This may be due to the fact that men are more likely than women to exhibit risky behaviour, particularly not waiting for the bus to stop, hanging on the side, and running to catch the bus (Mirza, et al., 1999). A review of bus crashes in Europe also indicated that men were over represented in in serious injury crashes (Albertsson & Falkmer, 2005).

Likewise, a study on health outcomes and safety behaviour for taxi drivers in Brisbane were predominantly male (94.5%) (Machin & De Souza, 2004). A survey of Norwegian taxi drivers also found that a high percentage of male drivers (85.4%) and male taxi drivers were more likely involved in RTC than female drivers (Raanaas & Anderson, 2008). A study among taxi drivers in New South Wales, Australia (2004) found that gender was found to be significantly associated with the risk of crash-related mortality and injury. The risk of crash-related mortality and injury of female taxi drivers was nearly 2.5 times less when compared with their male counterparts (Lam, 2004). There are no studies on gender and RTC among bus and taxi drivers in Vietnam. However, results of a study on RTCs in Vietnam found that 81% of the road traffic crashes were caused by males (Anh, et al., 2005).

Driver occupation and workload

Different occupations have different exposure to a crash (Dalziel & Job, 1997; af Wåhlberg & Dorn, 2009; Siskind, Steinhardt, Sheehan, O'Connor, & Hanks, 2011). A study on taxi crashes conducted by Dalziel and Job (1997) in Australia, found a significant negative correlation between number of crashes and time spent on breaks while working shifts. The taxi drivers with less time to break due to busy schedules or workload were more likely to be involved in RTC than drivers who had more time to rest in a working day. Working the night shift was significantly associated with an 60% increased risk of a crash among taxi drivers in New South Wales (Lam, 2004). A study on predictors for a crash among bus drivers in Sweden found that full-time drivers have higher crash risks than part-time drivers (af Wåhlberg & Dorn, 2009).

An analysis of bus crashes in Canada found that drivers who have regular rest times during the day have a lower number of crashes (Hamed, et al., 1998).

In general, the causes of RTCs are similar in the provinces of Vietnam. In terms of subjective causes, road-users lack consciousness of compliance with traffic rules when driving their vehicles and knowledge of traffic safety, and especially they engage in drinking and driving. Main objective causes include poor road conditions, insufficient traffic signs and increasing traffic density (Hanoi School of Public Health, 2009). According to police opinions, most of respondents said the main cause of RTCs is consciousness of road-users, particularly young ones aged from 18 to 35 years, who are often ebullient, eager to assert themselves, frequently exceeding speed limits and overtaking other vehicles in the road carelessly (Hanoi School of Public Health, 2009).

In Vietnam RTCs involving buses and taxis have been extensively covered by newspapers. The stressful work schedule of bus and taxi drivers were found to be the main contributing factor for a crash among this group, and other risk factors such as disorganised crossing behaviour from pedestrians and speeding from motorcyclists (Đoàn, 2006; Mạnh, 2007; Tùng, 2007). To increase profit margins, owners of public transport companies often demand that their drivers work long hours and drive even when exhausted (Đoàn, 2006; Mohan, et al., 2006).

2.2.2.2. Behavioural factors

Fatigue

Fatigue is considered a potentially important risk factor for motor vehicle crashes (Connor et al., 2002). Fatigue is a silent killer, and it is estimated to be responsible for up to 30% of deaths, and a bigger percentage of serious injury crashes in Western Australia (Office of Road Safety, 2007). High risk groups for a fatigue related crash include: young people, particularly males, aged 16–29 years; shift workers whose sleep is disrupted by working at night or working long, irregular hours (Gnardellis, Tzamalouka, Papadakaki, & Chliaoutakis, 2008) and people with untreated sleep apnoea syndrome or narcolepsy (Mohan, et al., 2006). A study on obstructive sleep apnoea among professional taxi drivers found that the odds of a crash for drivers reporting sleep apnoea increased with the age of drivers (Firestone, Mihaere, & Gander, 2009).

A study on taxi drivers found that 23% reported that they had fallen asleep at the wheel at some stage during their taxi driving career (Dalziel & Job, 1997). This study also found that drivers who have fallen asleep at the wheel at least once while driving a taxi had higher crash rates than those who had not.

Results from a study undertaken by Connor et al. (2002) found that driving while feeling sleepy, driving after five hours or through lack of sleep, and driving between 02:00 AM and 05:00 AM were associated with a 19% increase in the risk of a crash. Surveys of commercial and public road transport vehicles have also found that owners of public transport vehicles, in pursuit of increased profits, frequently force their drivers to drive at excessive speeds, to work long hours and to work when exhausted, which resulted in an increasing the proportion of drivers who were involved in crashes (Mohan, et al., 2006).

Several studies have found fatigue to be frequent risk factor for a crash among commercial drivers (Smith, Carrington, & Trinder, 2005; Tse, Flin, & Mearns, 2006; Williamson & Boufous, 2007). Evidence suggests that the time of day is more pertinent and, also, that changing shifts of work can result in increased sleep debt and difficulties in adapting to normal body circadian rhythms (Dalziel & Job, 1997; Walters, 2008; Firestone, et al., 2009). The risk of being involved in a crash doubles after 11 hours of driving; the risk of fatigue-related crashes is 10 times greater at night than during the day; and adequate time and facilities should be provided to allow breaks for rest, meals and naps (Peden M., et al., 2004).

In Vietnam, according to the Hanoi Transport Corporation (2008), there were about 60 crashes per year among the 600 buses in Hanoi in 2006. The main reasons for these crashes were driver fatigue, new migrant drivers unfamiliar with the routes, and congested roads (Đoàn, 2006; Transportation Department of Hanoi, 2008).

Seat-belts

The lack or inappropriate use of seat-belts is a risk factor for fatal and serious injury crashes. The most frequent and serious injuries occur to occupants unrestrained by seat-belts are to the head, chest and abdomen. Correctly used, seat-belts may reduce the risk of death in a crash by approximately 60% (Mohan, et al., 2006). Study on the benefits of seat-belts for drivers and front-seat passengers, has found that seat-belts

can reduce the risk of all injuries by 40–50%, of serious injuries by 43–65%, and of fatal injuries by 40–60% (Peden M., et al., 2004).

Rates of seat-belt use vary greatly among different countries, in low income and middle income countries, usage rates are generally much lower (Mohan, et al., 2006). In a study on seat-belts used among commercial motor vehicles, the majority of drivers (67%) reported that they used a seat-belt 'always' when driving. Fourteen percent responded that they used a seat-belt 'usually' while 7% claimed to use a belt 'about half of the time', eight percent said that they 'rarely' used seat-belts and 3% said 'never' (Kim & Yamashita, 2007). In this study, it found that a higher proportion of females (87.7%) always used seat-belts as opposed to males (64.6%), whereas older commercial drivers (72.7%) were more likely to wear seat-belts than younger drivers (60.5%) (Kim & Yamashita, 2007).

A study on the attitudes of taxi and nonprofessional male drivers in Israel, found that taxi drivers are more likely to undertake risky behaviour, especially related to seat-belts usage (Rosenbloom & Shahar, 2007). Studies using both roadside observations and interview surveys on seat-belt usage for taxi drivers in Nanjing, China found that approximately 31.7% of taxi drivers in the city wore seat-belts less often than other drivers (Routley, Ozanne-Smith, Qin, & Wu, 2009).

A study by Schaller on RTCs among taxis drivers found they were less likely to use restraints than drivers of other vehicles. Just over one fifth (23%) of taxi passengers involved in a crash were using a restraint at the time of the crash (Schaller, 2006). A study on seat-belt usage amongst taxi drivers in Beijing, China indicated that only 7.7% of taxi drivers wore seat-belts while driving (Passmore & Ozanne-Smith, 2006).

The main reasons given by commercial vehicle drivers who do not use seat-belts, were as follows, (29%) stated 'frequent stops/inconvenience' 23% claiming they were not 'not safety conscious'; other reasons included 'discomfort' (12%), 'no seat-belts' (6%), 'feel safe in big vehicle' (5%), and 12%, stating they 'didn't know' (Kim & Yamashita, 2007).

Presence of alcohol, mobile phones, and speed in relation to RTCs

Alcohol

Research has shown that alcohol consumption increases the risk of a RTC, as well as the severity of injuries (Mohan, et al., 2006). The extent to which alcohol contributes to RTCs varies between countries, thus direct comparisons are difficult to make. In many high income countries, about 20% of fatally injured drivers have excess alcohol in their blood (i.e. above the legal limit) (Williams, 2006; de Carvalho Ponce, MuÒoz, Andreuccetti, de Carvalho, & Leyton, 2011). Study on alcohol/drugs related fatal traffic crash in Hong Kong indicated that among the 106 cases of deceased drivers, alcohol and/or drugs were detected in 22 cases (21%) (Cheng, Chan, & Mok, 2005). Studies in low income countries have shown alcohol to be present in between 33% and 69% of fatally injured drivers (Mohan, et al., 2006) with drink driving contributing to more than one in every three fatal crashes (Mohan, et al., 2006).

A study on alcohol consumption among bus drivers in San Francisco, USA indicated that percentage of heavy drinkers was lowest in the youngest and the oldest age groups with male bus drivers more likely than female drivers to report heavy alcohol consumption (Ragland, Greiner, Krause, Holman, & Fisher, 1995). Other studies on bus and alcohol problems in the USA found that overall, 5.3% of transit operators were drinkers. Nearly 8% of operators reported alcohol-related harm in at least one area of their lives (Cunradi, Greiner, Ragland, & Fisher, 2003).

There are a limited number of studies specific to alcohol consumption and RTC among taxi drivers. One study on risk perception among taxi drivers in South Africa found that taxis drivers considered alcohol consumption to be less important as a contributing factor to a crash (Peltzer & Renner, 2003).

Mobile phones

The use of mobile phones can adversely affect driver behaviour in regards to physical tasks as well as perception and decision making (Caird, Willness, Steel, & Scialfa, 2008). Results of a meta-analysis of the impacts of mobile phones on driver performance have shown that driver performance can effect maintaining the correct lane position, keeping an appropriate speed, and judging and accepting safe gaps in the traffic (Caird, et al., 2008). There is also evidence that drivers who use mobile phones while driving, are at four times the risk for a crash (Mohan, et al., 2006).

There is no research on the impact of mobile phones and RTC among buses or taxis drivers. A number of epidemiological studies have reported drivers who use a mobile phone while driving have an elevated risk of being involved in a crash (Horberry, Bubnich, Hartley, & Lamble, 2001; Gras et al., 2007; Caird, et al., 2008). However, there is minimal research on actual road exposure rates to using mobile phone while driving and its association with crashes.

Research amongst New Zealand drivers has shown that more than half (57.3%) of drivers used a mobile phone occasionally while driving. There was also a significant relationship between crash involvement and use of a mobile phone whilst driving in studies by (Sullman & Baas, 2004; Backer-Gr¯ndahl & Sagberg, 2011). A study in Perth, Australia indicated that 9% of crashed drivers used mobile phones up to 10 minutes before the crash (McEvoy et al., 2005).

Speed

Speed is an important risk factor and can impact on the severity of a crash. Once a crash occurs, the relationship between speed and the outcomes of a crash is directly related to the energy that is released during a collision (Aarts & van Schagen, 2006). The risk of RTC increases as speed increases, especially at road junctions and when overtaking (Fleiter, Lennon, & Watson, 2010). A drivers' speed is influenced by a number of factors such as: human factors (age, sex, alcohol level, number of people in the vehicle); road and vehicle factors (road layout, surface quality, vehicle power and condition); environment factors (traffic density and composition, weather conditions, and other passengers of the cars) (Mohan, et al., 2006; Fleiter, et al., 2010). Wegman, Aarts and Bax (2008) estimated that if everyone were to comply with existing speed limits this would lead to a reduction of 25–30% in the number of casualties.

A study on the safety performance of bus companies found that higher speeds used by intercity buses were likely to result in injury crashes (Chang & Yeh, 2005). Another study on school bus crashes in the USA found that three quarters of school bus crashes were on roads with a speed limit under 70 kilometres per hour (Yang, et al., 2009). A meta-analysis on bus crashes in Europe (Albertsson & Falkmer, 2005) found that most bus crashes (73%) were on urban roads where the speed limit was 50 kilometres per hour. However, other results found that 83% of bus crashes were on a

road with a posted speed of 48 kilometres per hour, but 36% of bus and coach related fatalities occurred on roads with a 113 kilometres per hour speed limit. Another study on bus crashes in Sweden found that low speed limits resulted in a lower number of injuries when a crash occurred (af Wåhlberg, 2002).

A study on the characteristics and causes of bus crashes in Thailand reported that during the period 1997-2000, more than half of bus crashes were single vehicle crashes roll-over crashes. Excess speed was the main contributing factor responsible for 72% of crashes (Taneerananon & Somchainuek, 2005).

The study on environmental factors and RTCs of taxi driver in Australia mentioned that taxi drivers tended to rush to the waiting passengers for pick up. Under such circumstances, speeding as risky driving might occur. This, in turn, increases the risk of crash among these drivers (Lam, 2004). The study on risk taking in male taxi drivers in Canada indicated that the variation in speed between drivers contributes to collision rates and speeding behaviour had a clear relation to collision involvement and the severity of collisions (Burns & Wilde, 1995).

2.2.2.3. Passenger tolerance factors

Several studies examined about the association between carrying passengers and risk of crashes (M. L. Lin & Fearn, 2003; Cheng, et al., 2005). An analysis of national highway safety data suggests that having passengers in the car increases the likelihood of a fatal injury (Cheng, et al., 2005). The risk of crashes increases with an increase in the number of passengers. Carrying at least three passengers results in a threefold increase in the probability of suffering a fatal injury (M. L. Lin & Fearn, 2003). For taxi drivers, the presence of passengers is significantly associated with an increased risk for a crash in New South Wales. (Lam, 2004).

Buses and minibuses with passengers are frequently involved in crashes in low income countries. The use of open-backed vehicles for transporting passengers, particularly widespread in rural areas, presents the risk for passengers falling out of the back of the bus. In many low income and middle income countries, second-hand buses are imported without important crash-protective features – such as occupant restraints. Such vehicles present a high risk for an injury for passengers (Mohan, et al., 2006).

2.2.3. Environment/Temporal Factors

There is limited research examining environmental/temporal factors in relation to RTC among buses and taxis. The study by Weninger and Hertz (2007) found that a large number of crashes (27.5%) occurred between 03:00 PM and 09:00 PM due to bad weather conditions (heavy rain or snowfall, fog, glaze) (Weninger & Hertz, 2007). In Spain, 27% of bus and coach fatalities occurred in rain and/or drizzly weather (European Commission, 2008). However in Sweden, only 10% of all bus and coach casualties occurred in bad (snowy) weather conditions (European Commission, 2008). However, heavy wind seems to be capable of affecting the stability of bus/coaches, particularly on high-sided coaches (Albertsson & Falkmer, 2005).

A study on school bus crashes and injuries in USA found that the majority of the crashes occurred during a weekday (97%) with 40.7% of crashes occurring from 06:00 AM to 08:50 AM (Yang, et al., 2009). Another study in the USA found that 13.4% of bus crashes occurred between 04:00 PM and 07:00 PM (Strathman, Wachana, & Callas, 2010).

An analysis of all bus crashes in Hong Kong found that 8.9% of crashes occurred when weather condition were described as ‘light rain’ or ‘heavy rain’ (Evans & Courtney, 1985). Wahlberg’s study (2008) also suggested that weather has an impact on the risk for a crash with more crashes occurring on rainy days (af Wåhlberg, 2008).

A study on environment factors associated with RTCs among taxi drivers in New South Wales found temporal and environmental factors, such as the day and time of crashes, the weather conditions at the time of crashes, and special road features (e.g. narrow roadway, crest, steep grade, ditch, drain or culvert) may impact on crash risk (Lam, 2004). The results of this study found a 60% increase in the risk of a crash for taxi drivers driving during a night shift. (Lam, 2004). The results from study on taxi drivers and road safety in Sydney, Australia found the pattern of RTCs peaked between 01:00 AM to 05:00 AM (Dalziel & Job, 1996).

2.2.4. Vehicle Factors

2.2.4.1. Growth in Number of Motor Vehicles

Buses and taxis account for a large proportion of traffic in urban areas and they play an important role in road safety for all. However, there are no specific studies on RTC in relation to buses and taxis drivers. This part of review will use the information from other studies to discuss the increasing the number of motor vehicles on the road and its contribution to crash risk.

One of the main factors contributing to the increase in global RTC injuries is the growing number of motor vehicles. The problem is not just the growth in numbers of vehicles and accompanying increase in driving exposure, but also ensuring that appropriate road safety measures accompany this growth (Mohan, et al., 2006).

In relation to traffic exposures, a range of road safety experts have argued that traffic exposure, measured by vehicle flow, is the most important contributor to crash counts in an area (Jones et al., 2008). The results obtained from the study of Martin (2002) showed that crash rates are highest, both for damage-only and injury-crashes, in light traffic. The number of crashes is higher at weekends (or when truck traffic is restricted) (Martin, 2002).

One study conducted in Texas, found that traffic flow characteristics such as traffic volume, vehicle density, and the vehicle crash ratio (number of crashes over number of vehicles), have a direct influence on the likelihood and severity of a crash (Lord, Manar, & Vizioli, 2005). The study of Lord, Manar, and Vizioli (2005) showed that the higher the vehicle density, the greater the probability of being involved in a crash. However, the predictive models that use only traffic volume as a covariate may not capture adequately the characteristics of crashes on freeway segments (Lord, et al., 2005).

In Vietnam, the rapid economic development and urbanization in recent years has created a rapid increase in the number of vehicles including taxis and buses. Consequently, the number of traffic injuries and mortality due to road traffic crashes remain at a high level. Traffic injury information gained from the National Transportation Safety Committee and Hanoi Transport Department (2011) found that over the past 10 years, the number of vehicles has increased from 5 million vehicles to 20 million vehicles, in which motorcycles make up a main proportion. Currently,

in Hanoi, there are currently about 300,000 cars and 4 million motorbikes in Hanoi which is increasing by 15% to 20% per year (Department of Transport of Hanoi, 2011; Ministry of Transport of Vietnam, 2011). The Midterm Report on National Road Traffic Safety Strategies of Vietnam found that the main causes for RTCs in Vietnam were motorbikes (75%) followed by motor vehicle cars (17%) (Phong, 2010).

2.2.4.2. Braking and Maintenance

Incident circumstances within city buses in Austria during 1994–1998 were analysed. The general "accident" distribution showed that more than half of all injuries were caused by "emergency braking" (Albertsson & Falkmer, 2005). The result also revealed that in the category "no collision crashes", more than 95% of all casualties were caused by emergency braking. Emergency braking was also the cause for about one-third of the fatal injuries (European Commission, 2008). In non-crash bus and coach events, emergency braking seemed to be a major reason for injuries in 33–50% of the cases (European Commission, 2008). In Hanoi, Vietnam, the causes of RTCs involving buses were braking system problems (Dũng, 2003) and poor vehicle maintenance (Hoang, 2007; Minh, 2007).

2.3. Limitation of Studies on Road Traffic Crash and Injury of Bus and Taxi

Using a combination of search terms, 10 studies on taxis and 7 studies on buses with their key findings were identified. Detailing of each study is presented in the Table 2.1 and Table 2.2.

It was apparent that most of the studies were cross-sectional studies or secondary data analysis from police with various sample sizes. Most of the studies were undertaken in Australia, Canada, Sweden, and USA. There were few studies that have been undertaken in China or Thailand. There was no specific study on taxi drivers in Vietnam in relation to RTCs.

The majority of these studies tried to identify the prevalence, and describe several aspects of risk factors in relation to RTCs among taxis. These studies found that there was a marked difference in the prevalence of crash for taxis, compared to other

vehicles. A number of risk factors were analysed such as alcohol used, tobacco used, mobile phone used, seat-belt wearing, fatigue, passenger interference, and traffic violation in relation to RTC and severity of crashes.

Few studies attempted to identify the incidence and pertinent risk factors for a crash, or any follow up on cross-sectional studies. There was no evaluation studies undertaken related to taxi drivers. Most of the RTC studies on bus crashes were small-scale studies. They tried to identify the prevalence, and describe several aspects of risk factors in relation to RTCs among buses. Again, most studies were cross-sectional in nature. The majority of these studies examined the prevalence of bus crashes compared to other motor vehicles. A number of risk factors was identified such as age, gender, workload, shift work, alcohol used, mobile phone used, seat-belt wearing, and traffic violation. Few studies attempted to identify the incidence and pertinent risk factors associated with bus crashes.

Developments in technology, safety awareness, and transport legislation have generally reduced casualties among bus drivers and their passengers over the last few decades in developed countries, but it was not the case for developing countries. In relation to risk factors for a bus crash, there was a consideration of several factors; age, workload and shift work appeared to influence crash risk. Similar to studies examining crash risk for taxi drivers there are very few prevention and/or intervention studies undertaken specifically for bus crashes.

Table 2.1: Summary of recent epidemiological studies on RTC and risk factors of taxis

References	Methods, origin data, and study subjects	Outcome measures	Key findings
An investigation of behavioural adaptation to airbags and antilock brakes among taxi drivers (Sagberg, Fosser, & SÊtermo, 1997)	Cross-sectional study, using video recordings of all traffic in the direction towards the airport during a whole day (11 hours) in May 1995 and self-administer questionnaire. A total of 213 taxi drivers were included in the analysis.	To examine behavioural adaptation to safety equipment in the car: Speed and concentration on the trip to the airport; use of seat-belts; risk compensation.	During rush hours, speed of taxi was found to be clearly lower than at other hours Taxis with Anti-lock braking system (ABS) had significantly shorter time headways than taxis without ABS. Simple comparisons also showed fewer lane changes and a lower rate of seat-belt use among drivers of taxis with ABS.
Risk taking in male taxi drivers: relationships among personality, observational data and driver records (Burns & Wilde, 1995)	Cross-sectional study was carried out with direct observation of 51 taxi drivers and driver records from the Ministry of Transportation of Ontario in KINGSTON, Ontario, Canada in 1990	To examine the 'risk-taking' personality correlates of field measures of driver behaviour and driving records.	The percentage of these drivers who had one or more collision in 1990 was 19.6%. Individuals with a high propensity for sensation seeking take more risks while driving. They seem to drive faster and less carefully. Drivers with a traffic collision and violation history were positively related to observed risky driving behaviour.
Motor vehicle accidents, fatigue optimism bias in taxi drivers (Dalziel & Job, 1997)	Cross-sectional study was carried out in a group of 41 Sydney metropolitan taxi drivers in 1996 at Sydney, Australia.	To examine fatigue-related variables and their relationship with crash involvement. Number and length of breaks, employment type, falling	Among 41 taxi drivers, 36 crashes were recorded. Driver time-on-the-road is often considerable: 67% of those surveyed drove at least 50 hours per week, yet time off in long shifts (up to 12 hours) was often short (as low as 3 minutes, with an average of 37

References	Methods, origin data, and study subjects	Outcome measures	Key findings
		asleep at the wheel and a variety of other job-related and attitudinal variables were surveyed.	minutes). A significant negative correlation was found between number of crashes and total time of breaks (r= -0.31, p<0.02, one tailed). No significant relationship was found between 'driving safely when very tired' and crash group (non-crash group mean equal to 4.6, crash group mean equal to 4.3, t = 0.75, p > 0.05).
Taxi drivers' accidents: how binocular vision problems are related to their rate and severity in terms of the number of victims (Maag, et al., 1997)	Nested case control study was carried out in evaluation of the effects of medical and ophthalmologic conditions on safe driving from 1 January 1985 to 31 December 1990, in Quebec, Canada. Total of 116 taxi drivers results in 452 driver-years, with 331 corresponding to class 4C permit holders and 121 to other classes.	To estimate the effect of binocular vision problems on taxi drivers' distributions of crashes and distributions of the number of victims per crash (dead or injured).	Results show that taxi drivers have a large average number of crashes per year, larger for those with binocular vision problems compared with healthy ones, but not more severe in terms of the number of victims. The driver's past record (number of crashes and demerit points in the previous year) is a significant predictor of the number of crashes. Age is associated significantly with the number and the severity of crashes, with older drivers having a better record than the youngest group (30 years old or less).
Environmental factors associated with crash-related mortality and injury among taxi drivers in New South Wales,	Retrospective study was carried out in 2002, using information obtained from police reports of 7923 taxi drivers who were	To investigate the associations between some environmental factors and the increased risk of motor	10% of taxi drivers were killed or injured due to crashes. Sex, and two environmental factors are significantly associated with an increased risk of crash related mortality and

References	Methods, origin data, and study subjects	Outcome measures	Key findings
Australia (Lam, 2004)	involved in crashes on the roads between 1996 and 2000 in New South Wales, Australia	vehicle crash related injuries among taxi drivers.	injury among taxi drivers. Relative risk of crash-related mortality and injury is increased by 60% for those who work the night shift (OR =1.59, 95% CI: 1.35 to 1.88), and by 20% for those who do not carry any passengers on board (OR = 1.20, 95% CI: 1.02 to 1.41). The increased relative risk of crash-related mortality and injury is nearly 2.5 times for female taxi drivers (OR = 2.30, 95% CI: 1.45 to 3.65) when compared with their male counterparts.
Taxicab and livery crashes in New York city 2004 (Schaller, 2006)	This is an analysis of available data from New York State Department of Motor Vehicles. This analysis covers taxi and livery crashes occurring between 1990 and 2004.	To assess the level of safety of taxi cabs compared to other vehicles on the streets of New York Severity of crashes caused by taxicabs in term of passengers, pedestrians and bicyclists injured.	Crash rates are one-third lower for taxicabs and liveries than for other types of vehicles. Taxi and livery passengers are less likely to be injured while riding in a taxi/livery than are occupants of other vehicles. Taxis and liveries cause injuries to pedestrians at a lower rate than do other vehicles.
Differences between taxi and nonprofessional male drivers in attitudes towards traffic-violation penalties (Rosenbloom & Shahar, 2007)	Cross-sectional study was carried out with 80 male taxi drivers and 50 non-professional drivers in Israeli.	Attitudes towards traffic regulations of National Road Safety Authority of two driver groups	Non-professional drivers regarded traffic regulations as more just than taxi drivers Non-professional drivers judged the penalties as just and appropriate more than taxi drivers in the low-severity and in the

References	Methods, origin data, and study subjects	Outcome measures	Key findings
			medium-severity conditions.
Availability, functionality, and use of seat-belts in Beijing taxis prior to the 2008 Beijing Olympic Games (Fleiter, Gao, Qiu, & Shi, 2009)	An observation study was conducted with 231 Beijing taxis several months prior to the 2008 Beijing Olympic Games.	To examine seat-belt use and to explore Chinese drivers' attitudes toward using seat-belts	Results revealed that 21.2% of drivers were correctly wearing a belt, approximately half were not, and one third were using the belt in a non-functional way. Over 3/4 of this sample of taxi drivers were unrestrained while working. The percentage of functionally available belts was higher for front than rear passengers (88.3% and 22.9%, respectively)
Taxi driver seat-belt wearing in Nanjing, China (Routley, et al., 2009)	Cross-sectional study with multi-method approach was carried out in Nanjing, China from 2006 to 2007. Roadside observation: 9,294 taxi drivers were observed for seat-belt use. In-taxi observation: seat-belt wearing status was observed in April 2006 and 2007 from inside taxis during 286 routine trips. Interview survey: 234 taxi drivers were interviewed at taxi service centres for wearing practice.	To determine and validate patterns of seat-belt use and attitudes of taxi drivers on wearing a seat-belt following national and provincial seat-belt legislation in 2004-2005 Prevalence of seat-belt use and attitudes to wearing a seat-belt were determined, as were vehicle and driver characteristics, and comparisons with other motor-vehicle driver's seat-belt use and attitudes	Taxi drivers interviewed were predominantly male (95.3%). Taxi drivers wore seat-belts less often than other drivers in both the roadside observation and interview surveys. It was 31.7% of taxi drivers wore vs. 54.5% of other drivers from roadside observation survey and 56.4% of taxi drivers always wore vs.71.9% of other drivers from interview survey. Reasons for wearing seat-belts were associated with both wearing behaviour and vehicle type. Generally 'fine avoidance' was a more important reason to wear seat-belt for drivers of taxis than other vehicles. For those who never wore seat-belt, 'feeling uncomfortable' and 'trapped' were

References	Methods, origin data, and study subjects	Outcome measures	Key findings
	Focus group discussion: A focus group of 10 taxi drivers was held.		important reasons. Similarly for those who sometimes wore seat-belt, 'feeling uncomfortable' was an important reason for their not wearing occasions.

Table 2.2: Summary of recent epidemiological studies on RTC and risk factors of buses

References	Methods, origin data, and study subjects	Outcome measures	Key findings
Absence behaviour as traffic crash predictor in bus drivers (af Wåhlberg & Dorn, 2009)	Retrospective study was carried out, using available data from three sets of bus driver data. Two datasets were from a major United Kingdom bus company, and one from a small bus company in Sweden. Total data from 329 bus drivers in England and 150 bus drivers in Sweden, who had worked on full time schedules from 1999 to 2005, were included in the study.	The main aim of the study was to estimate the strength of the association between absence and traffic crashes. In the study, two crash variables were used (All crashes and Culpable crashes) to test the hypothesis that absenteeism is associated with crashes.	Age and length of service, where the collision elasticity turn positive at age 30. Regarding the age effect, the transition point estimated in this study occurs when bus operators are still relatively young. Absenteeism also contributes directly in the positive association between an operator's absence hours and his/her expected collision frequency; and indirectly through the absence-driven demand for extra board replacement operators. Drivers varied daily work spans are estimated to contribute to greater collision frequency. Collision and non-collision risk is greater during overtime shift hours. Fatigue related concerns associated with the disruptive effects of variable work assignments, are also supported by the positive link estimated between work span variability and expected collision frequency. Pressures to maintain a schedule are a key source of occupational stress. This study has found that running late is a significant contributor to the expected frequency of

References	Methods, origin data, and study subjects	Outcome measures	Key findings
			both collision and non-collision incidents.
Analysis of bus collision and non-collision incidents using transit ITS and other archived operations data (Strathman, et al., 2010)	The analysis focuses on 4,631 collision and non-collision incidents that occurred between 2006 and 2009. The study was at TriMet, the transit provider for the Portland Oregon metropolitan region	The study analyses factors contributing to bus operations safety incidents. Incident frequencies are estimated in relation to operators' demographic characteristics, employment status, assigned work characteristics, service delivery and performance indicators, temporal factors, and customer information	Incident frequencies are estimated to be related to both experience and age. Among operators who are still on probation, the expected frequency of collision and non-collision incidents is more than 19% and 35% greater, respectively, than the corresponding frequencies for regular operators. Frequency of non-collision incidents for female operators is 14% greater than their male counterparts The expected frequencies of collision and non-collision incidents are influenced by the average daily span of hours as well as span variability. For collisions, an increase in work span from, say, 10 to 11 hours is estimated to result in a 5.3% increase in collision frequency.
Distraction 'on the buses': A novel framework of ergonomics methods for identifying sources and effects of bus driver distraction (Salmon, Young, & Regan, 2011)	Qualitative study was conducted with 44 bus drivers, employed by the transport company. They were involved in various components of the study. Three focus group discussions involving 18 current bus drivers, and the	The study investigated the nature of bus driver distraction at a major Australian public transport company. The study included the sources of distraction present, and their effects on driver performance, through	A number of sources of distraction that could potentially distract bus drivers while driving buses were identified. These included sources such as eating, drinking and roadside advertisements. Others also included an additional set of distraction sources due to the requirements associated with bus operation, such as

References	Methods, origin data, and study subjects	Outcome measures	Key findings
	conduct of observational studies of 3 bus drivers driving a range of representative routes from Monash, Australia in 2009.	the application of a novel framework of ergonomics methods.	interaction with passengers and ticketing machines; failure to check front/back doors before closing them; failure to check bus stop for waiting passengers; failure to fully check mirrors before pulling away from bus stop; failure to maintain an appropriate position in lane; failure to check current speed or the current speed limit; and failure to adequately monitor traffic and pedestrians around the bus.
Analysis of commercial mini-bus accidents (Hamed, et al., 1998).	Cross-sectional study was conducted through personal interviews during July 1995, in three regions of Jordan: The Greater Amman, the city of Irbid, and the city of Zarka. A total of 438 mini bus drivers were randomly recruited for the study.	The study investigated traffic crashes related to bus drivers, such as number of crashes since obtaining driving license, time of crash, type of traffic crashes, and causes of traffic crashes. Information on other variables on driver site were also collected such as age, marital status, type of driving license, mini bus owner, year of experiences and working hours per day.	62% of all mini buses were involved in traffic crashes, with a yearly mean of 2.82 crashes per mini bus. Crashes peaks were in the PM time of the day. As the driver's experience with private vehicles increases, the risk of having a crash decreases. Driving experience as mini bus driver was significant and negatively correlated with crash risk. The age of a driver was also negatively correlated with crash risk, the older drivers had greater crash risk. The drivers, who had regular rest time during the day, had lower crash risk. Driving on dry pavements increased crash risk.

References	Methods, origin data, and study subjects	Outcome measures	Key findings
Burnout and alcohol problems among urban transit operators in San Francisco (Cunradi, et al.)	It was part of the cross-sectional Muni Health and Safety Study. Data were obtained from transit operators who underwent routine medical examination for driver's license renewal between August 30, 1993 and September 29, 1995. A total of 1974 workers underwent the exam, representing nearly the entire workforce of transit operators.	The study measured the burnout problem in relation to possible causes, concomitants, and consequences of burnout. The burnout scores were computed by assigning answers to related questions, a numeric value from 0 (never occurs) to 6 (occurs every day). Alcohol consumption and alcohol problems were also investigated.	The results of this study suggested that transit operators with higher levels of burnout, may be at elevated risk for alcohol problems. The mean of burnout scores was 18.2 (SD: 14.33). Woman drivers had significantly higher scores than men. An inverse linear trend was observed between age and burnout. Overall, 5.3% of transit operators were current drinkers. Nearly 8% of operators reported alcohol-related harm in at least one area of their lives. Younger workers were somewhat more likely to be alcohol dependent compared to workers in the oldest (55+) age group. There were no significant differences in the prevalence of either type of alcohol problems by household income, educational level, or seniority.
Is there a pattern in European bus and coach incidents? A literature analysis with special focus on injury causation and injury mechanisms (Albertsson & Falkmer, 2005).	A literature review on road traffic incident related to buses and coaches in Europe was undertaken. In the analysis, statistics regarding buses and coaches were summarized. The	The aim of the review was to identify and describe a pattern in bus and coach related incidents leading to injuries and fatalities in Europe, with special attention	The results showed that women travelled more frequently by bus as compared to men. Local bus travel was more frequent among people aged 17–20, as compared to those of other age groups. Local bus journeys were also frequent for the elderly.

References	Methods, origin data, and study subjects	Outcome measures	Key findings
	databases were electronically searched from 1980 to February 2004.	to injury causation and injury mechanisms.	Injuries sustained predominantly affected women 60 years of age and older. Of all traffic fatalities in Europe, bus and coach fatalities represented 0.3–0.5%. The risk of being killed or seriously injured was found to be seven to nine times lower for bus and coach occupants as compared to those of car occupants. The majority of RTCs of buses and coaches occurred on urban roads and in dry weather conditions. Buses and coaches most frequently collided with cars, but unprotected road users were hit in about one-third of all cases of a collision. Rollovers occurred in almost all cases of severe coach crashes. In this type of crash projection, total ejection, partial ejection, intrusion and smoke inhalation were the main injury mechanisms with more head and thoracic injuries.

Chapter 3: Methodology

Overview

This chapter summaries the research methods used in the study, including study location, operation definitions of study, study subjects, designs, data collection procedures, research variables, research instruments, data analysis, and ethical considerations.

3.1. Study Location

The study was conducted in Hanoi, the capital of Vietnam. Hanoi is one of the country's two biggest cities (Hanoi and Ho Chi Minh cities) with the highest number of public transport vehicles in Vietnam. Statistic data from General Statistic Office of Vietnam indicated that the most populous city was Ho Chi Minh City, with 7.1 million, followed by the capital city of Hanoi with 6.4 million (General Statistic Office, 2011).

Data from Midterm Report of Ministry of Transport of Vietnam showed that most vehicles were mainly located in Hanoi and Ho Chi Minh cities, accounting for 27% of motorcycles in the country. Hanoi has 3.65 million vehicles; Ho Chi Minh city has 4.04 million vehicles (Phong, 2010)

3.2. Operational Definitions

Key concepts (Mohan, et al., 2006)

- *Road traffic injury:* which occurred or originated on a road or street open to public traffic; which resulted in one or more persons being killed or injured, and in which at least one moving vehicle was involved.
- *Road traffic fatality:* a death occurring within 30 days of the RTC. "Any person killed immediately or dying within 30 days as a result of an injury crash".

Road traffic crash (Preventive Medicine Department, 2006a; Ministry of Police of Vietnam, 2009)

Definition of road traffic crash in this study was taken from the book "*Evaluation indicators for national injury prevention program implementation*", then the updated sub-classification in Circular No: 58/2009/TT-BCA (C11) from Ministry of Police of Vietnam in 2009.

"Road Traffic Crash" is a sudden contact/hit beyond the human being's subjective intention. It happens when all parties involved in movement in public transport, specialized road or in public traffic locations due to the violation of traffic rules or encountering unexpected events or situations without cautions leading to losses of life and certain damages to human's health and properties.

Definition of time variables (Yau, 2004)

- The period of the occurrence of a crash was classified according to the four seasons: January–March, April–June, July–September and October–December.
- The day of the occurrence of a crash was divided into two groups according to a weekday and weekend: the weekday was defined as Monday–Friday and the weekend was defined as Saturday–Sunday.
- The time of a crash was classified into two groups in accordance with the working hours, called rush hours (06:00 to 08:00 AM and 05:00 to 06:00 PM) and non-rush hour (the rest of the hours in a day).

Definition of light condition and weather variables (Yau, 2004)

- Street light conditions were classified into three categories: daylight, dawn/dusk, and night-time. In the analysis of association, street light conditions were grouped into two levels: daylight and dawn/dusk/night time.
- The weather variable was assigned into two categories: dry and wet conditions.

Definition of other variables (Yau, 2004)

- Road alignment: there were three categories in the classification of road alignment namely: curve and grade/hillcrest, straight and grade/hillcrest, and straight and level. In the analysis of association, road alignment was classified into two categories: straight and level roads and curve/hillcrest roads.

- Road user movement: there were nine movement actions of drivers classified in this study, they were: avoiding object in roadway; backing; changing lane; going straight ahead; leaving traffic lane; making left/right turn; merging; parked/slowing or stopped and stopped at the traffic light. In the analysis of association, road user movement was grouped into two levels: changing the lane/merging and not changing the lane/merging.

  Driver: Person in control of a bus or taxi and is working at designated Hanoi bus and taxi companies. To be eligible as a bus or taxi driver, a person must hold the appropriate level of driving licence and comply with strict regulations imposed by government and bus and taxi companies.

- Driver's license: Vietnamese driving licenses are mandatory for all drivers of motor vehicles, as well as for riders of motorcycles with a capacity of over 50cc. With motor vehicles, there are six levels of driving licenses available in Vietnam: B1, B2, C, B, E, and F levels (Ministry of Transport of Vietnam, 2007).

  - *Level B1: Passenger transport vehicle with up to nine seats, truck below 3500 kg not for commercial transport*
  - *Level B2: Passenger transport vehicle with up to nine seats, truck below 3500 kg with one trailer*
  - *Level C: Truck, tractor above 3500 kg with one trailer*
  - *Level D: Passenger transport vehicle with 10 to 30 seats*
  - *Level E: Passenger transport vehicle with more than 30 seats*
  - *Level F: Truck class B2, vehicle with trailer above 750 kg.*

- Hospitalisation: A person admitted to hospital as a result of a RTC and who did not die from injuries sustained in the crash within 30 days of the crash.

3.3. Study Design

The study consisted of two phases: (i) a retrospective study documenting the crashes of bus and taxi drivers for the past three years; and (ii) a prospective study collecting information on incidence and risk factors of RTCs among buses and taxis over a 12 month period.

3.3.1. Phase 1: Retrospective Study

The Government of Vietnam, along with public health professionals and the transport, labour and health sectors have expressed great concerns and interests in slowing down the major epidemic of RTC, especially for buses and taxis in the cities. The key step in RTC intervention is to determine the magnitude, scope, and characteristics of the problem, which necessitates the collection of trustworthy, representative and accurate data. To date, such data are not available. In this phase of the study, bus and taxi drivers in Hanoi were recruited to estimate the prevalence of RTC and crash characteristics.

This part of the chapter addresses objective 1 of the study "To estimate the prevalence of RTCs by bus and taxi drivers for the last three years, from 2006 to 2009".

3.3.1.1. Time frame

A retrospective design was considered appropriate to collect quantitative data in relation to: causes and types of RTC; characteristics of drivers involved in RTCs; circumstances of RTCs, and the health profile of drivers. The time frame for this retrospective study was 3 years, from March 2006 to March 2009. All information pertaining to the demographic of the bus and taxi drivers, driving experiences and also crash experiences were collected by structured questionnaires.

3.3.1.2. Subjects and recruitment

According to data from Hanoi Transport Department, there were six bus companies and 31 registered taxi companies in Hanoi in March 2008 (Hanoi Transportation Department, 2009). The total number of buses and drivers in the six companies were 548 buses and 741 drivers. With the taxi companies, there were 3657 cars and 4080 drivers.

To select taxi drivers, we set the inclusion criteria to determine the eligibility of taxi companies for recruitment of the study sample. Accordingly, the companies had to: be located in Hanoi; have a total number of cars and number of drivers bigger than 100; be established for more than two years and agree to interviews and follow up of drivers during the next 12 months.

From the list provided by Department of Transport of Hanoi, 14 taxi companies met the inclusion criteria and were all approached. However, for the time being, only five taxi companies accepted to participate in the study. The total number of interviewees of the study was 1214 taxi drivers. Details of the sampling procedure of taxi drivers are presented in Figure 3.1.

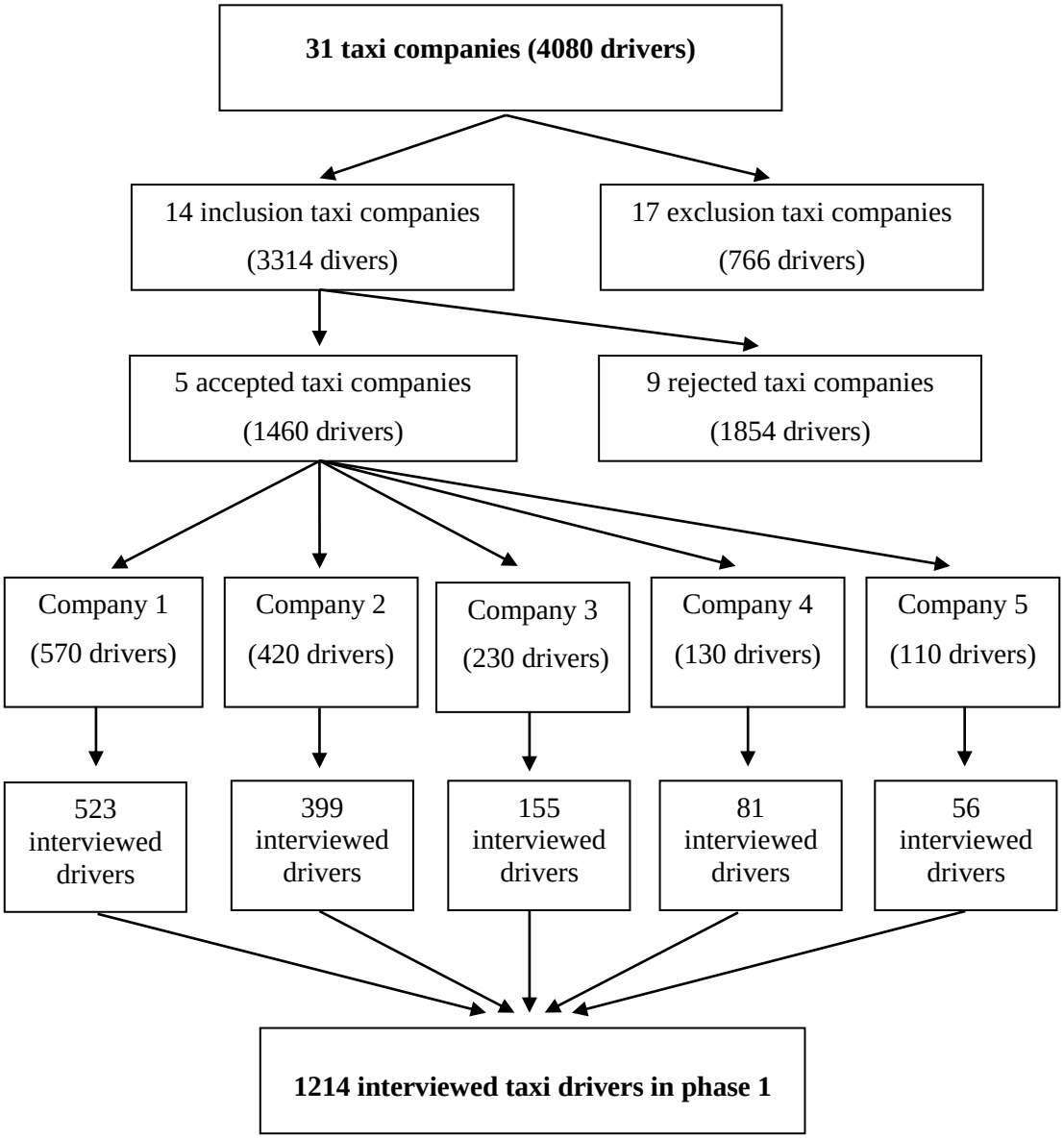

Figure 3.1: **Sampling frame of retrospective study in phase 1 of taxi drivers**

Acceptance rate of taxi companies was 35.7% and response rate was 83.2%. There were several reasons mentioned by the taxi companies as to why they did not wish to participate in the survey; most of them were concerned about the aspect of business safety, some others cited the busy schedules of their drivers.

To select bus drivers, after approaching all six bus companies, five companies were accepted to participate in the study. The total number of bus driver interviewees for this study was 365. Details of the sampling procedure of bus drivers are presented in Figure 3.2.

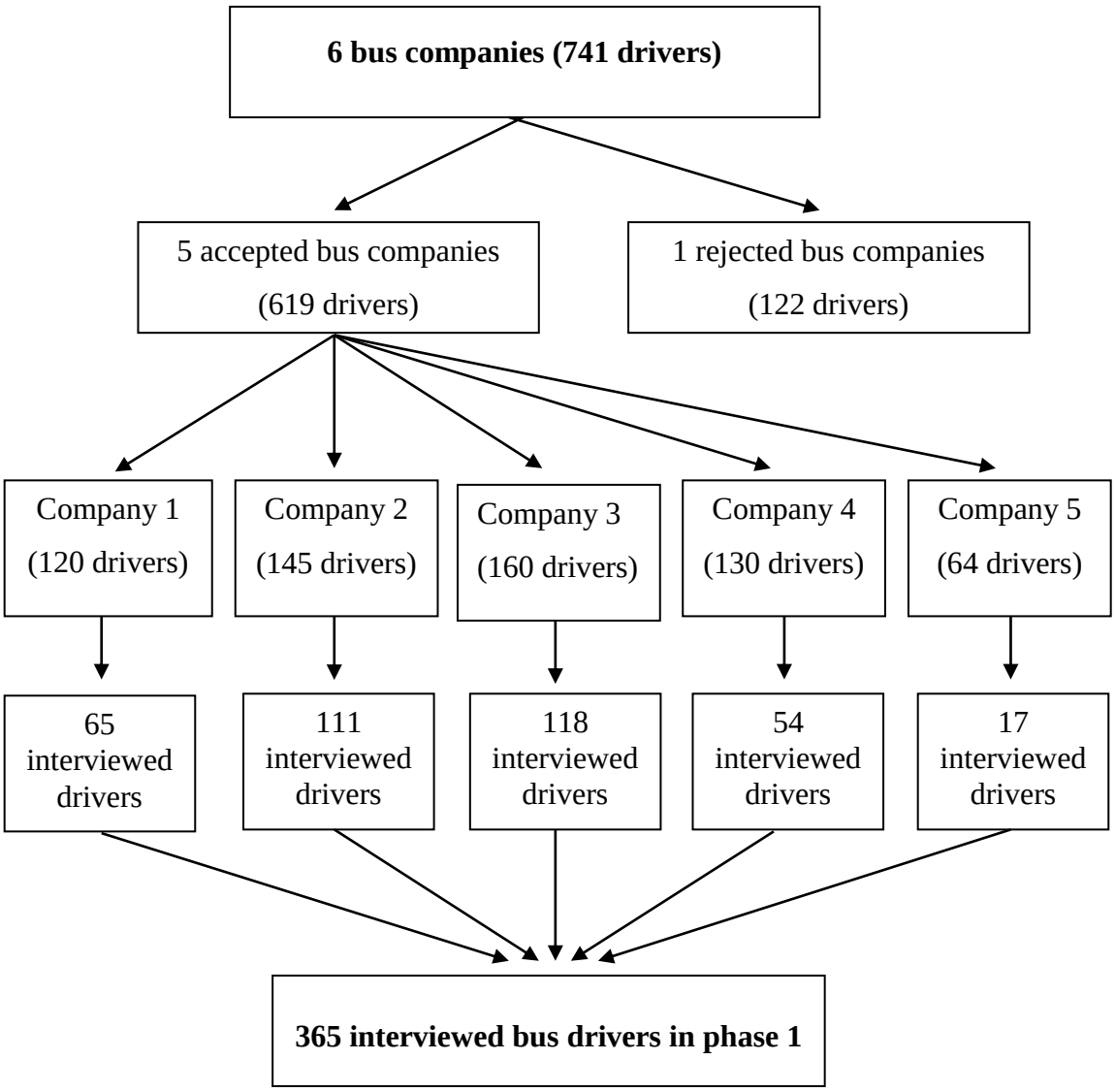

Figure 3.2: Sampling frame of retrospective study in phase 1 of bus drivers

Acceptance rate of bus companies was 83.3% and response rate was 58.9%. The low response rate was mainly due to the busy schedule and tiredness of drivers after long continuous working hours, they needed time to return home or move to a different location for another job.

3.3.1.3. Instrument and translation

To meet the phase 1 study objective, as well as to collect baseline information for phase 2, the structured questionnaire consisted of six sections: (i) identification and core demographics; (ii) crash related RTCs in last three years (2006-2009); (iii) lifestyle factors; (iv) current behavioural measurements; (v) self-reported health status; and (vi) current physical measurements.

The preliminary version of the questionnaire was first sent to road safety experts for comments and suggestions. The revised questionnaire was then professionally translated into Vietnamese. A convenience sample of 50 bus and taxi drivers was invited to establish the face and content validity of the instrument. After suitable modifications had been made, the final version of the questionnaire was translated back into English for final checking. The Vietnamese version was administered during the actual survey. A copy of the structure questionnaire is provided in Appendix 2.

3.3.1.4. Data collection

A structured questionnaire was administered face-to-face to collect quantitative information during the last three years from March 2006 to March 2009. This included the demographic information of drivers, normal habits of drivers such as smoking, drinking habit, seat-belt used, type and nature of the crashes, and other crash characteristics.

The data collection was conducted by the researcher and experienced research assistants from the Hanoi School of Public Health. A detailed description of the survey protocols, including the data collection process, signing of consent forms and data submission was documented clearly in a standard manual.

All research assistants have been involved in data collection procedures since the pilot phase for Vietnamese language consistency and logical progression of questions in the questionnaire. Training and support supervision were also provided to the research assistants to ensure consistency and quality throughout the data collection period. On average, the interview of each driver took about 30 minutes to complete.

3.3.1.5. Statistical analysis

Data processing took place immediately after completion of the data collection. Double data entry with the Epidata 3.1 program was applied to ensure correctness and quality of data input with double entry procedures. The quantitative data were managed and analysed using Statistical Package for the Social Sciences (SPSS) version 18.0. A prevalence estimate was generated for each driver subgroup of interest. Between-group differences and statistical association were assessed using t-test and Chi-square test in relation to behavioural, lifestyle characteristics and demographic information.

The key outcome variable, road traffic crash, was measured by the item: "During the past three years, how often, if at all, were you involved in RTC involving any kind of damage or injury to you or another person or vehicle while you were driving a bus/taxi?" (Response categories were 0–9, 10 = 10 or more). This variable was re-coded to a dichotomous outcome (yes = 1, no = 0) for subsequent analyses.

Logistic regression analysis was applied to identify the relationship between explanatory variables and RTC among bus and taxi drivers. The associations between the number of crashes of drivers and potential influencing factors were explored by using the Poisson regression model.

3.3.2. Phase 2: Prospective Study

This phase of study addresses objectives two and three of the study: (2) To assess the incidence of RTC, underlying exposures, type and severity of crashes during the 12 month follow up period, for the cohort of bus and taxi drivers identified from first phase of study and (3) To identify the pertinent risk factors affecting the severity of road traffic crashes for bus and taxi drivers.

3.3.2.1. Time frame

The second phase was conducted over a 12 months period. This phase of study determined the incidence of RTC among bus and taxi drivers, whom were recruited in phase one of the study. Potential factors of RTC include gender, age, driving experience, working schedule, time and place of crash, smoking, consumption of alcohol and other stimulants, road environment and conditions, adherence to safety

guidelines (speed, license, seat-belt use). Such information was collected after the crash happened.

3.3.2.2. Subjects and procedures

All bus and taxi drivers identified from the first phase were invited for participation in the prospective study. There were 1579 drivers (1214 taxi and 365 bus drivers) at the starting point of follow up. To investigate the relationship between RTC and "usual" behaviours and risk taking behaviours (Ameratunga et al., 2002), a sentinel surveillance system was implemented in this phase. Specifically, in the final week of every two-month period, the principal researcher and research assistants made contact with the team leaders of the taxi and bus drivers via phone to check if any crashes had occurred within the last two months.

The researcher or research assistants then approached the driver, who was involved in a crash, to collect data in relation to the crash using a standardized surveillance form (surveillance form is provided in Appendix 3). A post survey of all bus and taxi drivers (crash and non-crash experienced) was conducted after 12 months of follow up (post survey form is provided in Appendix 4).

After finishing the data collection for baseline information of retrospective phase, all 1214 taxi drivers were included in the cohort for the 12 month follow up period. There were six rounds of data collection in the follow up period. Every two months, all drivers were phoned to ask them about the history of RTCs within the last two months, any information about the status of job change and loss to follow up, were also documented. At the final stage of follow up, 225 (18.5%) taxi drivers were loss to follow up, either they changed their job or were unable to be contacted. Details of the 12 month follow up of taxi drivers are presented in Figure 3.3.

With 365 bus drivers being included in the cohort for the 12 month follow up, as with the taxi drivers, six rounds of data collection were set up. Every two months, all drivers were phoned about their history of crashes within the last two months, any information about the status of job change and loss to follow up were also documented. At the final stage of follow up, 39 (10.7%) bus drivers were loss to follow up, they changed their job or no contact details were provided. Details of the 12 month follow up of bus drivers are presented in Figure 3.4.

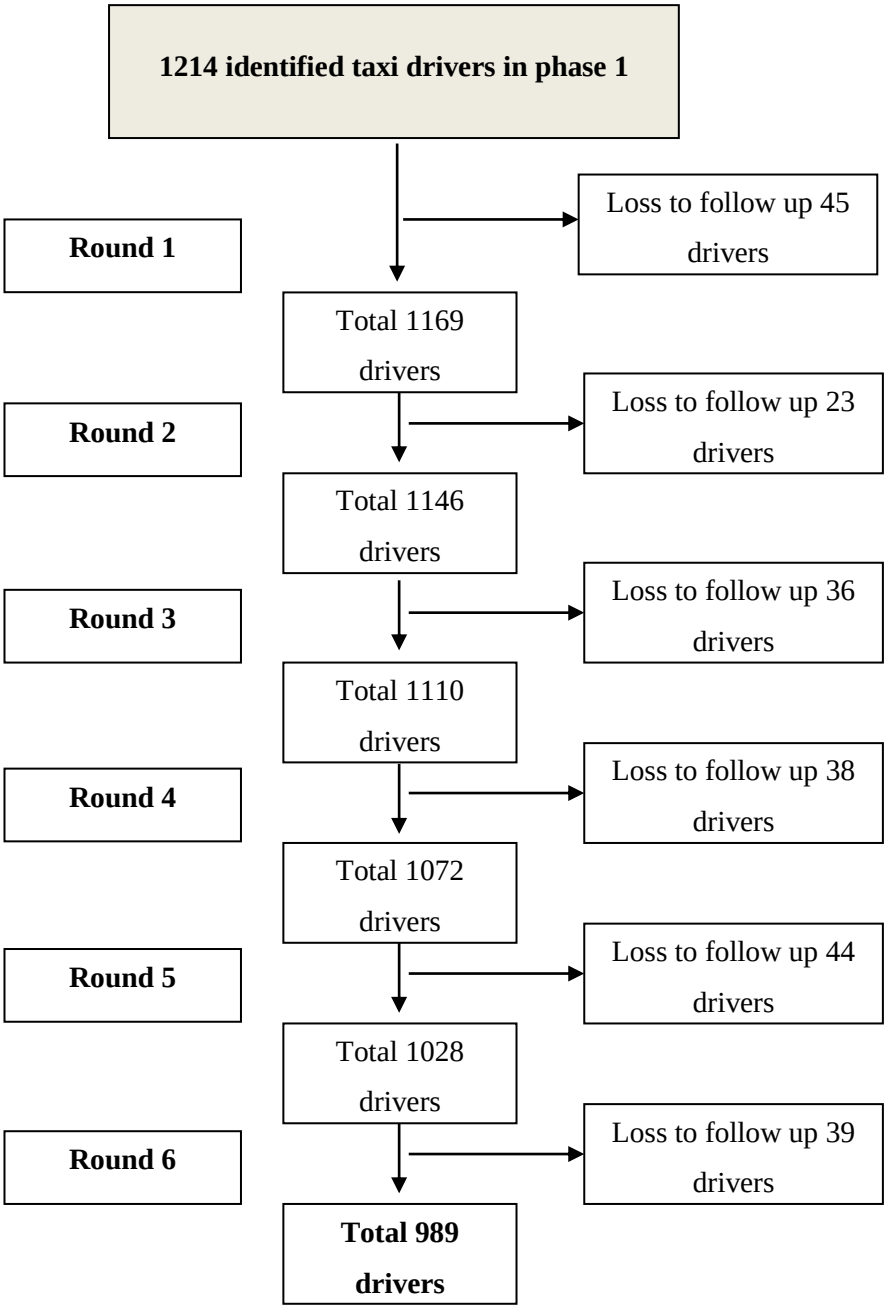

Figure 3.3: Sampling frame of prospective study in phase 2 of taxi drivers

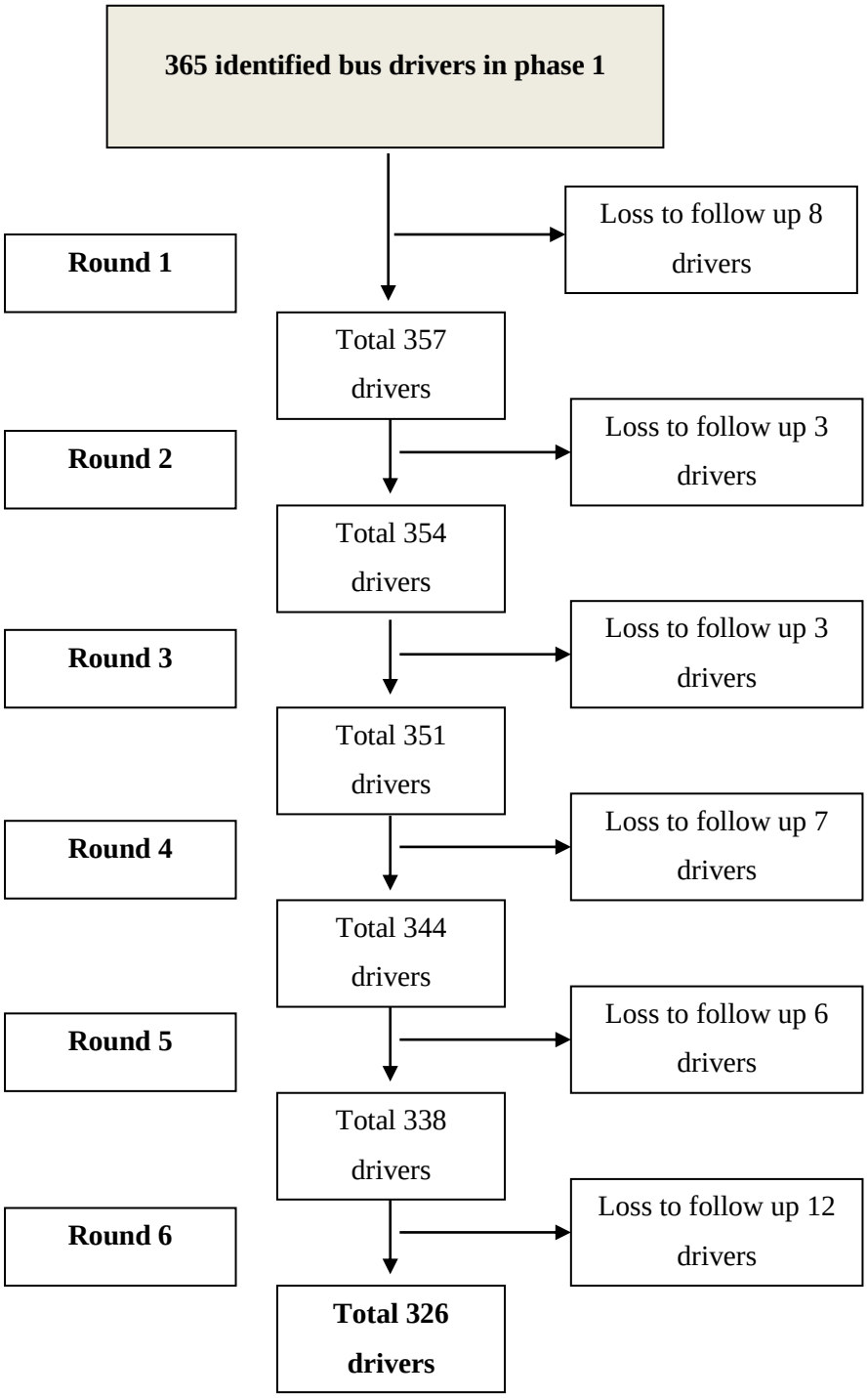

Figure 3.4: Sampling frame of prospective study in phase 2 of bus drivers

3.3.2.3. Instrument and translation

A surveillance form was used to collect quantitative data on the nature, circumstance, and related risk factors concerning each crash. Its development followed a similar process as that of the questionnaire in phase one of the study.

The post survey questionnaire was a reduced version of the Phase one questionnaire to measure behaviour changes and physical indicators of these drivers. The same data collection team conducted the post survey following the rigorous protocols developed previously.

3.3.2.4. Statistical analysis

The procedure for data entry and management was the same as that of Phase one. Analyses were performed on the incidence and types of RTCs of bus and taxi drivers. Besides univariate descriptive statistics such as t-test and Chi-square, multivariate analyses namely Poisson and logistic regressions were undertaken to explore the relationships between crash outcomes (RTCs and hospitalisation of person(s)) and variables of interest. Relative risks were estimated using adjusted odds ratio and incidence rate ratio from the logistic and Poisson regression model, respectively.

3.4. Variables of Study

3.4.1. Demographic Variables

To explore variables known or suspected to be associated with RTCs of drivers, additional information was collected related to gender, age, marital status, educational levels – the highest level of education attained, type of driving license (B1, B2, C, D, E, and F) and year gained, type of employment (full-time, part-time), number of working days, and number of working hours per day.

The highest level of education achievement of drivers was recorded using a twelve-point scale. The scale ranged from completion of primary school to a university degree. Please refer to Appendix 2 for details.

3.4.2. Lifestyle and Behavioural Variables

Information on lifestyle and behavioural patterns of drivers was collected. These variables were smoking (quantity and frequency of cigarette consumption), alcohol consumption (amount and frequency of drinking), fatigue (average hours of sleep,

medication for sleep or to stay awake), mobile phone use (pattern of use and penalty incurred), seat-belt use (frequency of wearing seat-belt when driving and penalty for not wearing seat-belt), speeding (habit and infringement incurred).

3.4.3. Crash Related Road Traffic Variables

Outcome variables of the study were RTCs of bus and taxi drivers. Information was collected on risk factors of RTC and exposure to the road environment (number of kilometres travelled), traffic violation of drivers, traffic conditions (gradient of the road, traffic density, traffic light, vision, weather condition), road infrastructure and place of crash (road under repair, highway, street, intersection, roundabout, bus stop, station).

3.5. Ethical Considerations

3.5.1. Consent

The study involved the administration of structured questionnaires and surveillance forms to obtain quantitative data. Approval of the study protocol was obtained from the Curtin University Human Research Ethics Committee ***(Approval Number HR 169/2007)***.

Written informed consent was sought from all study participants (bus and taxi drivers). The consent form, with an information sheet explaining the overall objectives of the study and the contact details of the principal investigator, was given to each participant. Participation was entirely voluntary. Confidentiality and the right to withdraw freely at any stage without any negative consequence were stressed throughout the study. A copy of the information sheet and consent form was provided in Appendix 1.

3.5.2. Confidentiality and Data Storage

All data collected were kept completely confidential and secured. No individual data can be released under any circumstances. Participants in this study were identified by ID code number only and not by name. In particular, individual data remained confidential and not to be released to managers of bus and taxi companies. No data that potentially reveals the identity of an individual can be used in any report. Computer databases were protected by password and accessible by the researchers only. The completed questionnaires were locked in a secured cabinet at Hanoi School

of Public Health after data entry was completed. Upon completion of the project, all these documents will be kept for seven years and in accordance with the regulations kept in a safe place. After that time all paper records will be destroyed.

Chapter 4: Results

Overview

This chapter will present results of a two-phase study. Results from phase 1, a retrospective study, will be presented for both taxi and bus drivers respectively, according to separate subheadings on demographic information, lifestyle and behavioural characteristics, traffic infringement history, crash information for the period 2006 to 2009, and correlation factors related to crash and number of crashes among these drivers.

Results from phase 2, a prospective study, will then be presented for taxi and bus drivers. This concerns information about crash incidence among drivers, crash characteristics, factors associated with RTC, and hospitalisation due to crash and contributing factors of drivers in a 12 month follow up period.

4.1. Retrospective Study

This phase of the study was carried out to achieve objective 1 of the study "To estimate the prevalence of RTCs by bus and taxi drivers for the last three years, from 2006 to 2009". Results of this study phase will be presented separately for taxi and bus driver groups.

4.1.1. Taxi Driver Group

4.1.1.1. Demographic information of taxi drivers

All 14 taxi companies were approached to get their approval for interviews; however, after several months of contact, only 5 taxi companies agreed to participate in the study. Acceptance rate of the companies was 35.7%. Total numbers of drivers of the 5 companies were 1460. We interviewed a total of 1214 drivers, giving a response rate of 83.2%.

In Table 4.1, the demographic data of these drivers are presented in two groups: those who have been involved in a crash, are called the crashed group; and those who have never been involved in a crash, are called the non-crashed group.

The age of taxi drivers ranged from 18 to 57 years old. The mean age was 31.9 (SD: 6.8) years old. Most of drivers were in the age group 25 - 44 years (83.3%). In this study, all drivers were male. The marital status of drivers in the crashed group was 39.9% not married, and in the non-crashed group was 33.7% not married.

In relation to their education level, most drivers completed high school (59.1%); very few of them only completed primary school (2.1%), and 5.4% graduated from college or university.

The average income per month of each driver was 3.7 (SD: 1.5) million Vietnam Dong (equivalence to 180 Australia dollars); 36.6% reported that their incomes were insufficient to support their lifestyle and family, and 11.3% stated they had to find extra jobs to earn a living.

Overall, the crashed group was younger, had lower income per month and a higher prevalence of insufficient income perceived than the non-crashed group.

Table 4.1: Demographic information of taxi drivers

Demographic variables		Crashed group		No crashed group		Overall		P value*
		Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	
Age groups (years)	Less than 25	40	14.5%	87	9.3%	127	10.5%	0.04
	From 25 to 44	220	79.7%	791	84.3%	1011	83.3%	
	More than 45	16	5.8%	60	6.4%	76	6.3%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	
	Mean (SD)	30.4 (6.4)		32.4 (6.9)		31.9 (6.8)		<0.01
Marital status	Not married	110	39.9%	316	33.7%	426	35.1%	0.06
	Married	166	60.1%	622	66.3%	788	64.9%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	
Education levels	Primary school or less (grade 1-5)	5	1.8%	21	2.2%	26	2.1%	0.57
	Secondary school (grade 6-9)	85	30.8%	320	34.1%	405	33.4%	
	High school (grade 10-12)	173	62.7%	544	58.0%	717	59.1%	
	College/University	13	4.7%	53	5.7%	66	5.4%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	

Demographic variables		Crashed group		No crashed group		Overall		P value*
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
Income per month (Vietnam Dong)	Mean (SD)	3,535,869.5 (1,325,134.5)		3,760,842.2 (1,593,042.7)		3,709,695.2 (1,538,618.8)		0.03
Sufficient income perceived	Sufficient	155	56.2%	615	65.6%	770	63.4%	<0.01
	Insufficient	121	43.8%	323	34.4%	444	36.6%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	

* ***Difference between crash and non-crash groups***

Table 4.2 presents the working history of taxi drivers. Analysis of the driving license levels of taxi drivers (definition of driving license levels was provided in Chapter 3), revealed there were 64.5% of drivers with a B2 level driving license, the beginning level of driving license for commercial motor vehicles, and only 1.7% drivers with E level.

The mean years of working as taxi drivers in the study was 2.59 (SD: 2.3) years, with the longest duration being 15 years and shortest 2 months. With the taxi companies, there were several types of contracts between the company and the drivers: full-time employment, employment by year, part-time employment, and casual work; only 6.7% of drivers had full-time employment and the remainder (93.3%) were part-time or employed on a casual basis. Of all drivers, about half (51.2%) migrated to work in Hanoi from other provinces.

As in other countries, drivers in taxi companies can do shift work; in the study group, 71.4% drivers did shift work. Working hours per day ranged from 4 hours to 24 hours. Mean working time per day was 12.7 (SD: 3.6) hours. Along with working time, the distance travelling for each driver ranged from 80 kilometres to 350 kilometres with a mean of 182.2 (SD: 48.5) kilometres per working day.

One important aspect of good driving is the recognition of being well rested. The average sleeping time perceived by the drivers in this study to be well rested was 7.8 (SD: 1.4) hours per day. However, not all drivers had enough time to sleep, the actual average sleeping time of these taxi drivers was 6.7 (SD: 1.7) hours per day (not shown in Table). As a consequence, 61.0% of drivers reported having suffered from tiredness when driving in the last year; about 10% of drivers reported suffering from frequent tiredness.

Other aspects of work history, including prior training to be taxi drivers is important. Most drivers received additional training (99.2%), since it was strictly regulated among all taxi companies in Hanoi. The training course normally took about 4 days.

Overall, the crashed group had higher level of licences, tended to work part-time, and suffered from tiredness when driving.

Table 4.2: Work history of taxi drivers

Work history variables		Crashed group		No crashed group		Overall		P value*
		Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	
Type of driving license	B level	158	57.2%	625	66.6%	783	64.5%	<0.01
	C level	114	41.4%	266	28.4%	380	31.3%	
	D level	4	1.4%	26	2.8%	30	2.5%	
	E level	0	.0%	21	2.2%	21	1.7%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	
Years of working as taxi drivers	Mean (SD)	2.5 (1.7)		2.6 (2.4)		2.59 (2.3)		0.34
Employment status	Full-time	10	3.6%	71	7.6%	81	6.7%	0.02
	Part-time	266	96.4%	867	92.4%	1133	93.3%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	
Type of worker	Migrant worker	132	47.8%	490	52.2%	622	51.2%	0.19
	Not migrant worker	144	52.2%	448	47.8%	592	48.8%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	
Do a shift work	Yes	179	64.9%	688	73.3%	867	71.4%	0.06
	No	97	35.1%	250	26.7%	347	28.6%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	

Work history variables		Crashed group		No crashed group		Overall		P value*
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
Working hours per day	Mean (SD)	12.8 (3.5)		12.6 (3.6)		12.7 (3.6)		0.35
Distance travelling per day (kilometres)	Mean (SD)	180.7 (48.2)		182.6 (48.6)		182.2 (48.5)		0.55
Perceived sleeping time needed	Mean (SD)	7.83 (1.4)		7.82 (1.4)		7.8 (1.4)		0.99
Suffered from tiredness when driving	Yes	188	68.1%	553	59.0%	741	61.0%	<0.01
	No	88	31.9%	385	41.0%	473	39.0%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	
Frequently suffered from tiredness when driving	Never	88	31.9%	385	41.0%	473	39.0%	0.02
	Rarely	20	7.2%	83	8.8%	103	8.5%	
	Sometimes	138	50.0%	366	39.0%	504	41.5%	
	Often	27	9.8%	96	10.2%	123	10.1%	
	Very often	3	1.1%	8	0.9%	11	0.9%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	

* ***Difference between crash and non-crash groups***

4.1.1.2. Lifestyle and behavioral characteristic of taxi drivers

Table 4.3 presents lifestyle and behavioral characteristic of taxi drivers. Four aspects of lifestyle and behavioural characteristics were investigated in the study: smoking status, alcohol consumption, mobile phone use, and seat-belt use. More than half of the drivers were smokers (54.4%). The average number of cigarettes consumed per day ranged from 1 to more than a pack of 20 cigarettes; 39.8% of drivers smoked 1-5 cigarettes per day and 6.1% smoked more than 20 cigarettes per day.

Alcohol consumption is also an important risk factor for RTCs. In the study, 60.7% of drivers had consumed alcohol in the last month. During each episode of drinking, each driver drank an average of 1.73 (SD: 0.86) standard drinks. With mobile phone usage, 64% of taxi drivers had made a call when driving.

Seat-belt wearing ensures the safety of drivers in case of a crash. However, results of the study showed that only half of the drivers always wore a seat-belt when driving (50.7%). Reasons the drivers gave for not always wearing a seat-belt were: ‘discomfort’ (25.9%), ‘frequent stops or due to inconvenience’ (14.9%), ‘feel safe in vehicle’ (9.6%), ‘no seat-belt or seat-belt faulty’ (1.1%), ‘not safety conscious’ (0.6%). Other reasons also mentioned included ‘not knowing the need to wear a seat-belt’; ‘short travel distance’, and ‘feeling hurried to catch passengers’. Overall, the crashed group appeared to have a lower seat-belt usage than the non-crashed group.

Table 4.3: Lifestyle and behavioural characteristics of taxi drivers

Lifestyle and behavioural characteristics		Crashed group		No crashed group		Overall		P value*
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
Smoking status	Smoker	150	54.3%	511	54.5%	661	54.4%	0.97
	Non Smoker	126	45.7%	427	45.5%	553	45.6%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100%**	
Number of cigarettes smoked per day	1-5 cigarettes	63	42.0%	200	39.1%	263	39.8%	0.51
	6-10 cigarettes	40	26.7%	161	31.5%	201	30.3%	
	11-20 cigarettes	38	25.3%	119	23.3%	157	23.8%	
	More than 20 cigarettes	9	6.0%	31	6.1%	40	6.1%	
	Total	**150**	**100.0%**	**511**	**100.0%**	**661**	**100%**	
Alcohol consumed last month	Yes	178	64.5%	559	59.6%	737	60.7%	0.14
	No	98	35.5%	379	40.4%	477	39.3%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	
Number of standard drinks per session	Mean (SD)	1.71(0.84)		1.74 (0.86)		1.73 (0.86)		0.42
Mobile phone used	Yes	186	68.4%	591	63.9%	777	64.0%	0.18
	No	90	32.6%	347	37.0%	437	36.0%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	

Seat-belt used	Never	44	15.9%	118	12.6%	162	13.3%	<0.01
	Seldom	40	14.5%	122	13.0%	162	13.3%	
	Sometimes	39	14.1%	92	9.8%	131	10.8%	
	Usually	42	15.2%	101	10.8%	143	11.8%	
	Always	111	40.2%	505	53.8%	616	50.7%	
	Total	**276**	**100.0%**	**938**	**100.0%**	**1214**	**100.0%**	

[*] ***Difference between crash and non-crash groups***

When drivers were asked about their traffic infringement history over the last 12 months; three quarters had been fined due to breaking traffic laws and regulations (details are in Table 4.4). The total number of traffic fines among 910 taxi drivers was 1088 with each driver making an average of 1.2 (SD: 0.44) traffic violations. The common traffic infringements were 'illegal parking and stopping' (86.5%); 'disregarding traffic control' (14.7%), and 'exceeding speed limit' (10.3%).

Table 4.4: Traffic infringement history of taxi drivers in last 12 months

Infringement history	Frequency	Percent
Yes	910	75.0%
No	304	25.0%
Total	**1214**	**100.0%**

4.1.1.3. Crash information of taxi drivers for period of 3 years (2006-2009)

According to the study's definition of a RTC, in the last three years, 1214 drivers were involved in 336 RTCs. The overall prevalence was 27.7% for a period of 3 years. Among these drivers, there were 93 RTCs that resulted in the hospitalisation of a person(s) (27.7%), whereas 243 (72.3%) RTCs involved property damaged only (details are presented in Table 4.5).

Table 4.5: Distribution of crashes among taxi drivers

Crash information	Frequency	Percent
Number of RTCs which involved a person(s) being hospitalised	93	27.7%
Number of RTCs involved with property damaged only	243	72.3%
Total number of RTCs	**336**	**100.0%**

Table 4.6 presents the frequency of crashes by taxi drivers in relation to number and outcome of crashes. For the last three years of working as a taxi driver, of the 1214 taxi drivers, 276 had at least one crash (22.7%), 18.6% drivers had been involved in one crash, 4.1% had been involved in two crashes or more. With respect to classification of crashes, 6.6% of drivers were involved in crashes that resulted in hospitalisation of person(s), and 16.5% of drivers were involved in crashes that resulted in property damaged only.

A crash can result in one or several victims being hospitalised; 24.4% of crashes had one victim hospitalised, 4.2% of crashes resulted in two hospitalisations. There were only two crashes with three hospitalisations; and one crash resulted in six hospitalisations. In addition, 4.2% of drivers got injured due to their crashes.

Most RTCs involving taxi drivers occurred on street roads (55.7%), 18.2% on highways, 23.2% in cross-intersections, and 3% at taxi bays. According to management and regulations of companies, most of the crashes have been reported to companies (89.3%).

When looking at self-reported contributing factors to crashes of taxi drivers, among those who had been in a crash, the most frequently mentioned factor was 'third party fault' (34.5%), followed by 'not under proper control' (18.8%), 'too fast condition' (18.5%), 'distraction or inattention' (11.0%), 'crowded road' (10.1%), 'misjudge clearance' (6.5%). None mentioned the use of medicine or drug involvement as contributing to the cause of crashes.

Table 4.6: Frequency of crashes by taxi drivers

Number of crashes	Frequency	Percent
Total number of crashes of each driver		
0	938	77.3%
1	226	18.6%
2	44	3.6%
3	4	0.3%
4	2	0.2%
Total	**1214**	**100.0%**
Crashes involved hospitalisation of person		
0	1134	93.4%
1	67	5.5%
2	13	1.1%
Total	**1214**	**100.0%**
Crashes involved with property damaged only		
0	1014	83.5%
1	165	13.6%
2	29	2.4%
3	4	0.3%
4	2	0.2%
Total	**1214**	**100.0%**

From the results of univariate analysis, there were some factors appeared to be significantly different between crashed group and non-crash group of taxi drivers such as: age of drivers, sufficient income perceived, type of driving license, employment status, suffered from tiredness when driving, and seat-belt used.

4.1.1.4. Factors affecting crashes of taxi drivers

To explore the factors affecting the crashes of taxi drivers in the last three years, binary logistic regression with presence of RTC as the outcome variable (yes = 1, no = 0) was applied; the independent variables being both continuous and categorical variables. The average number of kilometres travelled per day of drivers was controlled for in the regression model. The analysis resulted in six significant factors, namely: age of drivers, type of driving license, type of workers, insufficient income perceived, seat-belt used, and traffic infringement history. Details are presented in Table 4.7.

For every one year change in age, the potential to be involved in a RTC decreased by 5% (OR = 0.95; 95% CI: 0.92 to 0.97). According to the type of driving license, a level B driving license was less likely to be involved in a RTC compared to higher level driving licenses. Drivers who held higher level driver licenses were more likely to be involved in a RTC by about 1.56 times (95% CI: 1.17 to 2.09). Part-time employment was also more likely to be involved in a RTC by 2.22 times (95% CI: 1.09 to 4.54) when compared to full-time employment group. With regard to income, if a driver reported insufficient income to support their family, they were more likely to be involved in a RTC 1.44 times (95% CI: 1.08 to 1.93) than other drivers who perceived sufficient income. Similarly, drivers who had been issued with a traffic violation were more likely to be involved in a RTC about 1.87 times (95% CI: 1.30 to 2.71) than those who had never had a traffic violation whilst driving a taxi. Last but not least in the regression model, drivers who did not always wear a seat-belt, were more likely to be involved in RTC compared to drivers who always wore a seat-belt.

Table 4.7: Factors associated with road traffic crashes of taxi drivers

Independent variables		Taxi drivers		Statistic values			
		Total	**Crashed**	**Crude OR**	**Adjusted OR**	**95% CI**	**P value**
Age of drivers	Mean (SD)	31.9 (6.8)	30.4 (6.4)	**0.95**	**0.95**	**0.92-0.97**	**<0.01**
Education levels	Secondary school and below*	341	90 (20.9%)	1.18	1.03	0.74-1.36	0.96
	High school and above	597	186 (23.8%)				
	Total	**1214**	**276**				
Marital status	Not married*	426	110 (25.8%)	0.77	1.04	0.75-1.44	0.80
	Married	788	166 (21.1%)				
	Total	**1214**	**276**				
Type of driving license	Level B*	783	158 (20.2%)	**1.49**	**1.56**	**1.17-2.09**	**<0.01**
	Level C, D, E	313	118 (27.4%)				
	Total	**1214**	**276**				
Years of working as taxi drivers	Mean (SD)	2.59 (2.3)	2.5 (1.7)	0.97	1.03	0.96-1.11	0.44
Employment status	Full-time*	81	10 (12.3%)	**2.17**	**2.22**	**1.09-4.54**	**0.02**
	Part-time	1133	266 (23.5%)				
	Total	**1214**	**276**				
Do a shift work	Yes*	867	179 (20.6%)	1.49	1.32	0.96-1.80	0.08
	No	347	97 (28.0%)				
	Total	**1214**	**276**				
Sufficient income perceived	Sufficient*	770	155 (20.1%)	**1.48**	**1.44**	**1.08-1.93**	**0.01**
	Insufficient	444	121 (27.3%)				
	Total	**1214**	**276**				

Smoking status	Non Smoker*	553	126 (22.8%)	0.99	0.92	0.69-1.22	0.58
	Smoker	661	150 (22.7%)				
	Total	**1214**	**276**				
Alcohol consumed last month	No *	447	98 (20.5%)	1.23	1.09	0.81-1.47	0.54
	Yes	737	178 (24.2%)				
	Total	**1214**	**276**				
Mobile phone used	No*	437	90 (20.6%)	1.21	1.02	0.75-1.38	0.91
	Yes	777	186 (23.9%)				
	Total	**1214**	**276**				
Seat-belt used	Always*	616	111 (18.0%)				
	Usually	143	42 (29.4%)	**1.89**	**1.67**	**1.06-2.62**	**0.04**
	Sometimes	131	39 (29.8%)	**1.92**	**1.84**	**1.18-2.86**	**<0.01**
	Seldom	162	40 (24.7%)	**1.49**	**1.55**	**1.01-2.37**	**0.03**
	Never	162	44 (27.2%)	**1.69**	**1.59**	**1.04-2.44**	**0.03**
	Total	**1214**	**276**				
Suffered from tiredness when driving	No*	437	88 (18.6%)	1.19	1.24	0.91-1.68	0.16
	Yes	741	188 (25.4%)				
	Total	**1214**	**276**				
Infringement history	No*	304	45 (14.8%)	**1.95**	**1.87**	**1.30-2.71**	**<0.01**
	Yes	910	231 (25.4%)				
	Total	**1214**	**276**				

**** Reference category***

The relationship between the frequency of crashes of taxi drivers and 14 independent variables were explored by using Poisson regression model. The outcome variable was the number of RTCs during the last three years; the exposure variable was average number of kilometres travelled in working day of drivers. Details are presented in Table 4.8.

The results showed five factors were associated with RTC frequency, namely: age of drivers, type of driving license, perceived insufficient income, seat-belt used, and traffic infringement history. With the age of drivers, the expected change in number of crashes diminished with age (IRR=0.96, 95% CI: 0.94 to 0.98). In general, the older a driver was the less frequent involved in crashes. Similar to the logistic model, the type of driving license was also a significant predictor variable for the number of crashes. These drivers who held a higher level driving licenses tended to be involved in more crashes with a relative risk of 1.38 (95% CI: 1.10 to 1.72). Income was also a significant factor. Insufficient income put pressure on drivers to travel faster in order to catch more passengers. In this model, the drivers, who perceived insufficient money for their family, tended to increase their crash frequency by about 1.33 (95% CI: 1.06 to 1.67). Related to seat-belt wearing and number of crashes involved, drivers who did not always wear a seat-belt, appeared to be involved in more crash, than other drivers who always wore a seat-belt; the relative risks were all statistically significant and ranged from 1.62 to 2.06. Finally, drivers with an infringement history tended to be involved in more crashes than other drivers without infringement history, after adjusting for other confounding factors. These factors were the same as those identified by logistic regression analysis.

Table 4.8: Factors associated with frequency of crashes of taxi drivers

Independent variables		Statistic values		
		IRR	**95% CI**	**P**
Age of drivers		**0.96**	**0.94-0.98**	**<0.01**
Education levels	Primary school or less* High school and above	0.95	0.75-1.20	0.69
Marital status	Not married* Married	0.99	0.77-1.28	0.95
Type of driving license	Level B* Level C D E	**1.38**	**1.10-1.72**	**0.01**
Years of working as taxi drivers		0.99	0.93-1.05	0.79
Employment status	Full-time* Part-time	1.66	0.93-2.94	0.08
Do a shift work	Not do a shift work * Do a shift work	0.93	0.73-1.18	0.55
Sufficient income perceived	Sufficient* Insufficient	**1.33**	**1.06-1.67**	**0.01**
Smoking status	No Smoker* Smoker	1.05	0.84-1.31	0.64
Alcohol consumed last month	No* Yes	1.01	0.79-1.28	0.93
Mobile phone used	No* Yes	0.93	0.73-1.17	0.53
Seat-belt used	Always*			
	Usually	**1.62**	**1.16-2.28**	**<0.01**
	Sometimes	**2.05**	**1.48-2.83**	**<0.01**
	Seldom	**1.74**	**1.23-2.43**	**<0.01**
	Never	**1.80**	**1.29-2.50**	**<0.01**
Suffered from tiredness when driving	No* Yes	1.16	0.91-1.48	0.22
Infringement history	**No*** **Yes**	**1.63**	**1.20-2.19**	**<0.01**

**** Reference category***

4.1.2. Bus Driver Group

4.1.2.1. Demographic information of bus drivers

All six bus companies in Hanoi were approached to get their approval for interview, but only five bus companies agreed to participate in the study. Acceptance rate of the companies was 83.3%. Total number of drivers in five companies was 619. A total of 365 drivers were interviewed, the response rate being 59.7%.

In Table 4.9, the demographic data are presented in two groups: those drivers that have been involved in a crash are called the crashed group and drivers who have never been involved in a crash are called the non-crashed group.

In our study, all drivers were male. Most drivers were in the age groups less than 45 years old (74.2%). The mean age of all drivers was 39.2 (SD: 7.2) years old. The distribution of marital status was: 12.1% not married and more than 87% married and living with a partner.

Of the vast majority of drivers (82.5%) completed high school or had a university education. The average income per month of each driver was 3.7 (SD: 0.6) million Vietnam Dong (equivalence to 185 Australia dollars). When asked about the sufficiency of income to support their family, 12.1% of the drivers reported their income was insufficient.

Overall, the crashed group was younger, had lower education level, higher income per month, but perceived insufficient income than the non-crashed group.

Table 4.9: Demographic information of bus drivers

Demographic variables		Crashed group		No crashed group		Overall		P value*
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
Age groups (years)	Less than 45	65	89.0%	206	70.5%	271	74.2%	<0.01
	More than or equal to 45	8	11.0%	86	29.5%	94	25.8%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
	Mean (SD)	35.5 (5.5)		40.1 (7.3)		39.2 (7.2)		0.00
Marital status	Married	67	91.8%	254	87.0%	321	87.9%	0.26
	Not married	6	8.2%	38	13.0%	44	12.1%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
Education levels	Secondary school or less (grade 6-9 and below)	24	32.9%	40	13.7%	64	17.5%	<0.01
	High school and above (grade 10-12 and above)	49	67.1%	252	86.3%	301	82.5%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
Average income per month (VND)	Mean (SD)	3,828,767 (438,583)		3,661,855 (645,212)		3,693,424 (612,785)		0.03
Sufficient income perceived	Sufficient	27	37.0%	206	70.5%	233	87.9%	<0.01
	Insufficient	46	63.0%	86	29.5%	132	12.1%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	

* ***Difference between crash and non-crash groups***

Table 4.10 presents the working history of bus drivers. There were 96.7% of drivers with an E level driving license; 2.2% held a D level (98.9% hold level D and E); and 1.1% held an F level. The distribution of driving licenses was not different between crashed and non-crashed groups.

A bus transportation system has been available in Hanoi for about 30 years. The mean number of years working as bus drivers in the study group was 6.77 (SD: 4.62) years, with the longest being 22 years and the shortest being 6 months. There were several types of contract between the company and its drivers: full-time employment, employment by year, part-time employment, and casual work. The majority (75.6%) of drivers were full-time employees. Of all drivers, 72.1%% were from Hanoi.

The working hours per working day ranged from 6 hours to 9 hours; depending on the shift work and also the days of the week. The mean working time in a day was 7.9 (SD: 0.52) hours for both groups. Along with working time, the distance of travel for each driver ranged from 100 kilometres to 280 kilometres, with an average travel distance of 175.1 (SD: 37.2) kilometres per working day.

The reported average sleeping time required for bus drivers to feel rested was perceived to be 7.8 (SD: 1.4) hours. From the results of the study, the mean sleeping time of each bus driver was 6.5 (SD: 1.5) hours. Of the drivers, 82.7% reported suffering from tiredness when driving in the last year, and 26% experienced frequent tiredness.

Overall, the crashed group had less years of driving a bus, was mostly migrant workers, travelled less distance per day, more frequent suffered from tiredness, in comparison to the non-crashed group.

Table 4.10: Work history of bus drivers

Work history variables		Crashed group		No crashed group		Overall		P value*
		Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	
Type of driving license	D and E level	72	98.6%	289	99.0%	361	98.9%	0.82
	F level	1	1.4%	3	1.0%	4	1.1%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
Years of working as bus drivers	Mean (SD)	4.90 (3.74)		7.24 (4.70)		6.77 (4.62)		<0.01
Employment status	Full-time	61	83.6%	215	73.6%	276	75.6%	0.07
	Part-time	12	15.4%	77	26.4%	89	24.4%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
Type of worker	Not migrant worker	26	35.6%	237	81.2%	263	72.1%	<0.01
	Migrant worker	47	64.4%	55	18.8%	102	27.9%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
Working hours per day	Mean (SD)	7.9 (0.22)		7.8 (0.56)		7.9 (0.52)		0.35

Work history variables		Crashed group		No crashed group		Overall		P value*
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
Distance travelling per day (kilometres)	Mean (SD)	159.7 (28.8)		178.9 (38.1)		175.1 (37.2)		<0.01
Perceived sleeping time needed	Mean (SD)	7.83 (1.4)		7.82 (1.4)		7.8 (1.4)		0.99
Suffered from tiredness when driving	No	8	11.0%	55	18.8%	63	17.3%	0.11
	Yes	65	89.0%	237	81.2%	302	82.7%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
Frequently suffered from tiredness when driving	Rarely	10	13.7%	79	27.1%	89	24.4%	<0.01
	Sometimes	52	71.2%	126	43.2%	178	48.8%	
	Often	11	15.1%	87	29.8%	98	26.8%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	

* ***Difference between crash and non-crash groups***

4.1.2.2. Lifestyle and behavioral characteristic of bus drivers

In the Table 4.11, among the bus drivers, 53.7% were smokers. The average number of cigarettes consumed per day ranged from 1 to more than a pack of 20 cigarettes; of the drivers who smoked, 35.7% smoked 1-5 cigarettes, and 6.1% smoked more than 20 cigarettes per day.

In relation to alcohol, 68.8% of drivers had consumed at least one standard drink within the last month before the time of the interview. With mobile phone usage, 66.0% of the drivers were using a mobile phone whilst driving a bus.

Only 10.2% of bus drivers always wore a seat-belt. The reasons given for not always wearing seat-belts were: ‘discomfort’ (54.9%), ‘feel safe in vehicle’ (21.6%), ‘no seat-belt or seat-belt fault’ (19.2%), ‘do not know need to use’ (5.8%), and ‘inconvenience’ (2.1%).

Overall, the prevalence of alcohol drinking and pattern of seat-belt usage were different between the crashed and non-crashed group.

Table 4.11: Lifestyle and behavioural characteristics of bus drivers

Lifestyle and behavioural characteristics		Crashed group		No crashed group		Overall		P value*
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
Smoking status	Smoker	34	46.6%	162	55.5%	196	53.7%	0.17
	Non smoker	39	53.4%	130	44.5%	169	46.3%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
Number of cigarettes smoked a day	1-5 cigarettes	12	35.3%	58	35.8%	70	35.7%	<0.01
	6-20 cigarettes	19	55.9%	95	58.6%	114	58.2%	
	More than 20 cigarettes	3	8.8%	9	5.6%	12	6.1%	
	Total	**34**	**100.0%**	**162**	**100.0%**	**196**	**100.0%**	
Alcohol consumed last month	No	13	17.8%	101	34.6%	114	31.2%	<0.01
	Yes	60	82.2%	191	65.4%	251	68.8%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	
Number of standard drink per session	Mean (SD)	1.18 (0.43)		1.65 (0.75)		1.54 (0.71)		<0.01
Mobile phone used	Yes	49	67.1%	192	65.8%	241	66.0%	0.82
	No	24	34.2%	100	32.9%	124	34.0%	
	Total	**73**	**100%**	**292**	**100%**	**365**	**100%**	

Lifestyle and behavioural characteristics		Crashed group		No crashed group		Overall		P value*
		Frequency	Percent	Frequency	Percent	Frequency	Percent	
Seat-belt used	Always	8	9.9%	29	11.0%	37	10.2%	<0.01
	Sometimes	5	15.1%	44	6.8%	49	13.4%	
	Seldom	8	27.4%	80	11.0%	88	24.1%	
	Never	52	47.6%	139	71.2%	191	52.3%	
	Total	**73**	**100%**	**292**	**100%**	**365**	100%	

* ***Difference between crash and non-crash groups***

Table 4.12 presents the traffic infringement history of the bus drivers within the last 12 months. Just over one fifth (23.3%) of bus drivers have been fined due to breaking the traffic laws such as: 'illegal parking and stopping' (72.9%), 'disregarding traffic control' (12.9%), and 'exceeding stated speed limit' (3.6%). No drivers were fined due to 'talking on mobile phone' and 'non-use of seat-belt'.

Table 4.12: Traffic infringement history of bus drivers in last 12 months

Infringement history	Frequency	Percent
Yes	85	23.3%
No	280	76.7%
Total	**365**	**100.0%**

4.1.2.3. Crash information of bus drivers for period of 3 years (2006-2009)

Table 4.13 and Table 4.14 present the distribution and frequency of crashes among bus drivers from March 2006 to March 2009. There were 76 RTCs among 365 bus drivers in the past 3 years. The overall prevalence was 20.8% for a period of 3 years. Among these drivers, there were 56 RTCs resulting in hospitalisation (73.7%), whereas 20 RTCs involved property damaged only (26.3%).

Among all 365 bus drivers, 73 drivers (20%) had been involved in one or two crashes for the last three years; 56 drivers (15.3%) had been involved in a crash which resulted in hospitalised person(s). The locations of the crashes were: 80.8% on a street/local road, 5.5% on the highway, 8.2% at a cross-intersection, and 5.4% at bus stops.

Table 4.13: Distribution of crashes among bus drivers

Crash information	Frequency	Percent
Number of RTCs that involved a person(s) being hospitalised	56	73.7%
Number of RTCs involved with property damaged only	20	26.3%
Total number of RTCs	**76**	**100.0%**

Table 4.14: Frequency of crashes by bus drivers

Number of crashes	Frequency	Percent
Total Number of crashes of each driver		
0	292	80.0%
1	70	19.2%
2	3	0.8%
Total	**365**	**100%**
Crashes involved hospitalisation of person		
0	309	84.7%
1	56	15.3%
Total	**365**	**100%**
Crashes involved with property damaged only		
0	348	95.3%
1	14	3.8%
2	3	0.8%
Total	**365**	**100%**

From the results of univariate analysis, there were some factors appeared to be significantly different between crashed group and non-crash group of bus drivers such as: age of drivers, education levels, sufficient income perceived, year of working as bus drivers, type of workers, distance travelling per day, frequently suffered from tiredness when driving, alcohol consumed last month, and seat-belt used.

4.1.2.4. Factors affecting crashes of bus drivers

To explore the contributing factors affecting the crashes of bus drivers in the last three years, binary logistic regression with presence of RTC as the outcome variable (yes = 1, no = 0) was applied; the independent variables being both continuous and categorical variables. The average number of kilometres travelled per day by the drivers was controlled for in the model. Regression analysis resulted in two significant factors namely: migrant workers and perceived insufficient income to support family. Details are presented in Table 4.15.

Drivers from other provinces who migrated to work as bus drivers in Hanoi were 4.26 times (95% CI: 2.20 to 8.25) more likely to be involved in a RTC, compared to drivers who were from Hanoi. In relation to income, if a driver reported insufficient money to support their family, they were 2.6 times (95% CI: 1.37 to 4.93) more likely to be involved in a RTC, compared to other drivers who perceived sufficient income.

Table 4.15: Factors associated with road traffic crashes of bus drivers

Independent variables		Bus drivers		Statistic values			
		Total	**Crashed**	**Crude OR**	**Adjusted OR**	**95% CI**	**P value**
Age of drivers	Mean (SD)	39.2 (7.2)	35.5 (5.5)	0.89	0.95	0.89-1.00	0.07
Marital status	Married*	321	67 (%)	1.67	1.34	0.47-3.79	0.58
	Not married	44	6 (%)				
	Total	**365**	**73**				
Education levels	High school and above (grade 10-12 and above)*	301	49 (16.3%)	3.08	1.79	0.82-3.90	0.13
	Secondary school or less (grade 6-9 and below)	64	24 (37.5%)				
	Total	**365**	**73**				
Years of working as taxi drivers	Mean (SD)	6.77 (4.62)	4.90 (3.74)	0.85	0.94	0.85-1.04	0.28
Type of worker	Not migrant worker*	263	26 (9.9%)	**7.79**	**4.26**	**2.20-8.25**	**<0.01**
	Migrant worker	102	47 (46.1%)				
	Total	**365**	**73**				
Sufficient income perceived	Sufficient*	233	27 (11.6%)	**4.08**	**2.60**	**1.37-4.93**	**<0.01**
	Insufficient	132	46 (34.8%)				
	Total	**365**	**73**				
Smoking status	Smokers*	196	39 (19.9%)	1.86	1.80	0.96-3.37	0.06
	No smokers	169	34 (20.1%)				
	Total	**365**	**73**				
Alcohol consumed last month	No*	112	13 (11.6%)	2.44	1.55	0.72-3.35	0.26
	Yes	253	60 (23.7%)				

	Total	**365**	**73**				
Mobile phone used	No*	124	24 (19.4%)	0.82	1.04	0.53-2.05	0.89
	Yes	241	49 (20.3%)				
	Total	**365**	**73**				
Seat-belt used	Always*	37	8 (21.6%)				
	Sometimes	49	5 (10.2%)	0.41	0.42	0.11-1.58	0.20
	Seldom	88	8 (9.1%)	0.36	0.41	0.12-1.32	0.13
	Never	191	52 (27.2%)	1.35	0.77	0.28-2.05	0.60
	Total	**365**	**73**				
Suffered from tiredness	No*	63	8 (12.7%)	1.88	1.55	0.63-3.83	0.33
	Yes	302	65 (21.5%)				
	Total	**365**	**73**				
Infringement history	No*	280	56 (20.0%)	1.00	1.85	0.89-3.86	0.09
	Yes	85	17 (20.0%)				
	Total	**365**	**73**				

**** Reference category***

The relationship between the frequency of crashes of bus drivers and 12 independent variables were explored by using the Poisson regression model. The results in Table 4.16 showed two statistically significant factors, namely: type of workers (migrant workers) and insufficient income to support family. Migrant workers appeared to be involved in more crashes than non-migrant workers. Drivers who reported earning insufficient money for their family tended to have higher frequency of crashes than those who reported sufficient income, after adjusting for other confounding factors. These two factors were the same as those identified by logistic regression analysis.

Table 4.16: Factors associated with frequency of crashes of bus drivers

Independent variables		**Statistic values**		
		IRR	**95% CI**	**P**
Age of drivers		0.97	0.92-1.01	0.23
Education levels	High school and above* Secondary school or less (grade 6-9 and below)	1.23	0.44- 2.45	0.91
Marital status	Not married* Married	1.04	0.72-2.12	0.43
Years of experiences in driving a bus		0.93	0.85-1.02	0.12
Type of worker	Not migrant worker* Migrant worker	**2.89**	**1.67-4.98**	**<0.01**
Sufficient income perceived	Sufficient* Insufficient	**1.73**	**1.03-2.94**	**0.03**
Smoking status	No* Yes	0.73	0.46-1.17	0.20
Alcohol consumed last month	No* Yes	1.45	0.75-2.82	0.26
Mobile phone used	No* Yes	0.99	0.61-1.63	0.991
Seat-belt used	Always*			
	Sometimes	0.46	0.15-1.42	0.18
	Seldom	0.54	0.22-1.39	0.21
	Never	0.73	0.33-1.62	0.44
Suffered from tiredness	No* Yes	1.46	0.67-3.18	0.33
Infringement history	No* Yes	1.74	0.96-3.14	0.06

**** Reference category***

4.2. Prospective Study

The first objective of phase 2 was to assess the incidence of RTC, underlying exposures, type and severity of injuries during the 12 month follow up. The second objective was to identify the pertinent risk factors of severity of RTCs among bus and taxi drivers in Hanoi, Vietnam.

4.2.1. Taxi Driver Group

4.2.1.1. Crash incidence of taxi drivers in 12 month follow up

After finishing the data collection for baseline information of the retrospective phase, all 1214 taxi drivers were recruited to be part of the cohort of a 12 month follow up period. There were 6 rounds of data collection in the follow up period. Every 2 months, all drivers were phoned to enquire their history of RTCs within the last 2 months. Information about the status of job change and loss of follow up were also documented. At the final stage of follow up, 18.5% of drivers had been lost to follow up. Among the drivers who had maintained follow-up, the proportion of drivers involved in crashes ranged from 1.2% to 3.3% per 2 month period within six rounds. Figure 4.1 shows RTCs and loss to follow up proportion of 1214 drivers in phase 2 of study.

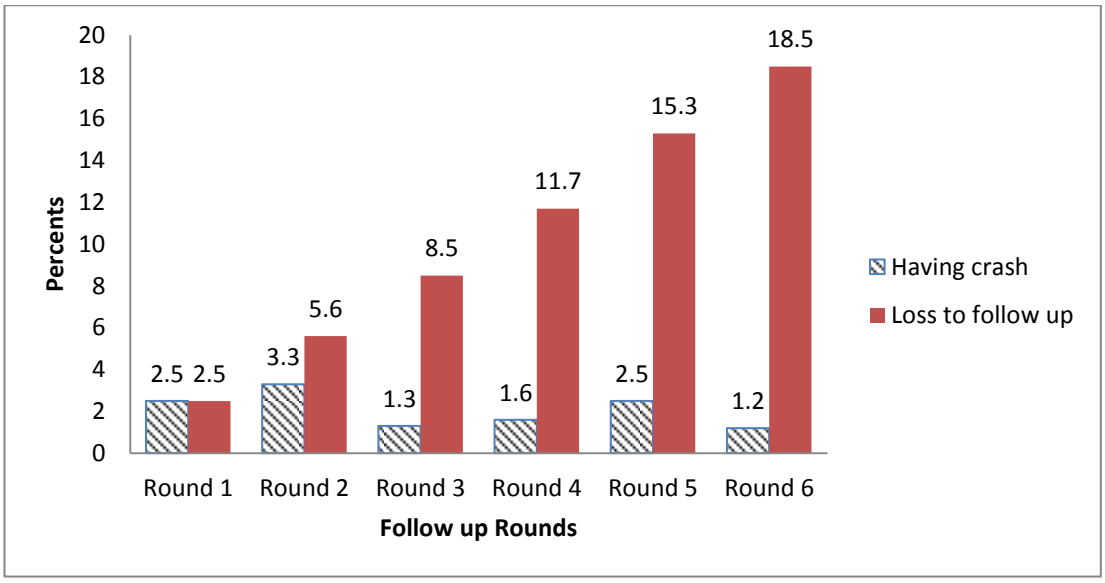

Figure 4.1: Percentage of having crashes and loss to follow up among taxi drivers

Among the cohort of 1214 taxi drivers, there were 145 (11.9%) drivers who had been involved in at least one RTC. A total of 148 crashes occurred during the 12 month follow-up period; 97.9% of crash drivers were involved in 1 crash, and only 2.1% (3 drivers) were involved in 2 crashes. Cumulative Incidence was 0.122 in 12 months. Details are given in Table 4.17.

Table 4.17: Distribution of 148 crashes among 1214 taxi drivers

Frequency of crashes		**Frequency**	**Percent**
Number of crashes of each driver	0	1069	88.1%
	1	142	11.7%
	2	3	0.2%
	Total	**1214**	**100.0%**
Cumulative Incidence	**148/1214 = 0.122**		

To find the influencing factors associated with RTCs for taxi drivers in follow up, binary logistic regression was performed between the binary dependent variable of having a crash and 11 demographic and behavioural variables. The results of regression analysis are presented in Table 4.18.

The results indicated that suffering from fatigue increased the risk of RTC for taxi drivers in Hanoi. It remained significant even after adjusting for demographics and other behavioural variables in the model. Drivers, who experienced tiredness when driving a taxi, were more likely to be involved in a RTC 1.54 times (95% CI: 1.04 to 2.29) than drivers who did not suffer from tiredness when driving. Other factors such as age of drivers, perceived insufficient income to support family, year of working experience, which were significant in the retrospective study, were not statistically significant in this phase of the study.

Table 4.18: Factors associated with road traffic crash of taxi drivers in 12 month follow up

Independent variables		Taxi Drivers		Statistic values			
		Total drivers	**Crashed**	**Crude OR**	**Adjusted OR**	**95% CI**	**P value**
Age of drivers	Mean (SD)	31.9 (6.8)	30.4 (6.4)	0.96	0.98	0.95-1.01	0.27
Marital status	Married*	788	93 (11.8%)	1.04	0.92	0.61-1.39	0.70
	Not married	426	52 (12.2%)				
	Total	**1214**	**145**				
Education levels	High school and above (grade 10-12 and above)*	783	91 (11.6%)	1.09	1.14	0.79-1.66	0.46
	Secondary school or less (grade 6-9 and below)	431	54 (12.5%)				
	Total	**1214**	**145**				
Year of working as taxi drivers	Mean (SD)	2.59 (2.3)	2.60 (2.3)	1.00	1.02	0.94-1.11	0.51
Migrant worker	Not migrant worker*	592	70 (11.8%)	1.02	0.97	0.60-1.39	0.89
	Migrant worker	622	75 (12.1%)				
	Total	**1214**	**145**				
Sufficient income perceived	Sufficient*	770	86 (11.2%)	1.22	1.15	0.80-1.66	0.42
	Insufficient	444	59 (13.3%)				
	Total	**1214**	**145**				
Alcohol consumed last month	No*	477	61 (12.8)	0.88	0.79	0.55-1.14	0.21
	Yes	737	84 (11.4)				
	Total	**1214**	**145**				

Mobile phone used	No*	437	44 (10.1%)	1.33	1.19	0.80-1.76	0.36
	Yes	777	101 (13.0%)				
	Total	**1214**	**145**				
Seat-belt used	Always*	616	62 (10.1)	1.44	1.38	0.96-1.97	0.07
	Not always	515	83 (13.9)				
	Total	**1214**	**145**				
Suffered from tiredness	No*	473	48 (8.9%)	**1.66**	**1.54**	**1.04-2.29**	**0.02**
	Yes	741	103 (13.9%)				
	Total	**1214**	**145**				
Infringement history	No*	304	28 (9.2%)	1.45	1.38	0.89-2.16	0.14
	Yes	910	117 (12.9%)				
	Total	**1214**	**145**				

**** Reference category***

4.2.1.2. Crash characteristics of taxi drivers in 12 month follow up

Figure 4.2 shows the time the crashes occurred. Time of crash occurrence started from 04:00 AM in the morning to 11:00 PM at night time. High frequency of crashes happened during rush hour from 06:00 AM to 08:00 AM and from 05:00 PM to 06:00 PM.

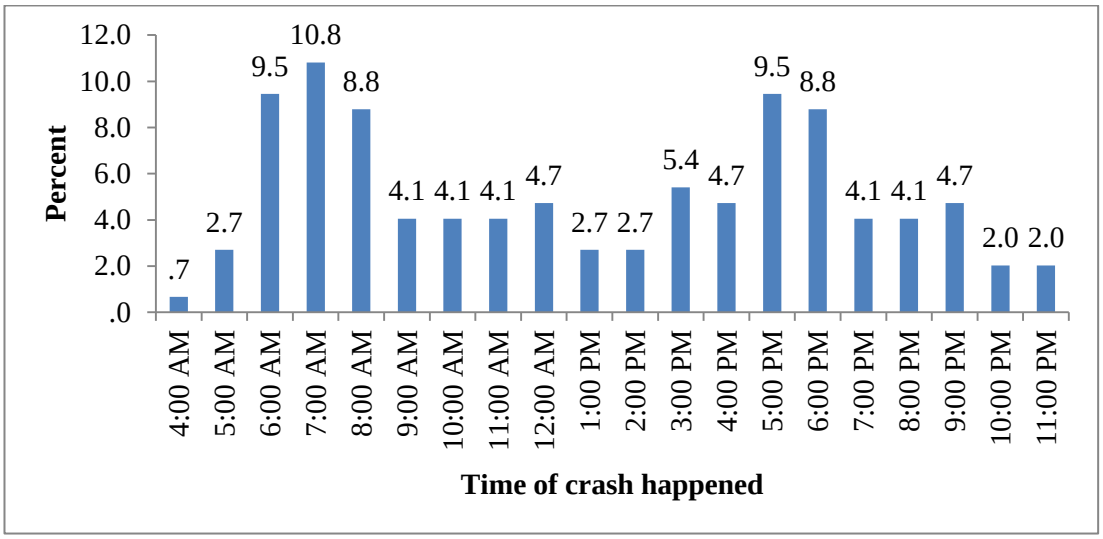

Figure 4.2: Time of crash among taxi drivers

Table 4.19 and Table 4.20 present respectively the type and location of crashes among taxi drivers in 12 month follow up. Because of the high density of motorbikes in Hanoi, the crashes between taxis and motorbikes accounted for the largest proportion (59.5%) of crashes; followed by cars (33.1%). Most of the crashes (89.9%) occurred on a local street road and 71.6% happened on straight and level roads.

Table 4.19: Type of crashes among taxi drivers during 12 month follow up

Vehicle/object	Frequency	Percent
Taxi - Car	49	33.1%
Taxi - Motorbike	88	59.5%
Taxi - Bicycle	2	1.4%
Taxi - Pedestrian	1	0.7%
Hit a tree/pavement	8	5.4%
Total	**148**	**100.0%**

Table 4.20: Location and road alignment of taxi crashes in 12 month follow up

Location and Road Alignment		Frequency	Percent
Location of crash	Highway	15	10.1%
	Street road	133	89.9%
	Total	**148**	**100.0%**
Road alignment	Curve and grade/hillcrest roads	20	13.5%
	Straight and grade/hillcrest roads	22	14.9%
	Straight and level roads	106	71.6%
	Total	**148**	**100.0%**

With regard to weather, 75.7% of crashes occurred during dry conditions. As shown in Table 4.21, 62.2% of crashes happened during daylight; 18.2% at dawn or dusk time and 19.6% at night time. With respect to taxi movement, 49.6% of RTCs occurred when the driver was changing/leaving the lane or making left/right turn or merging.

Table 4.21: Weather, light conditions and taxi driving action before the time of a crash

Weather, light conditions and driving action		Frequency	Percent
Weather condition	Dry	112	75.7%
	Wet	36	24.3%
	Total	**148**	**100.0%**
Light condition at the time of crash	Dawn/dusk	27	18.2%
	Daylight	92	62.2%
	Night	29	19.6%
	Total	**148**	**100.0%**
Traffic density	Crowded road	77	52.0%
	Not crowded road	71	48.0%
	Total	**148**	**100.0%**
Taxi movement	Avoiding object in roadway	7	4.7%
	Backing	7	4.7%
	Changing lane	22	14.9%
	Going straight ahead	55	37.2%
	Leaving traffic lane	18	12.2%
	Making left/right turn	15	10.1%
	Merging	11	7.4%
	Parked/slowing or stopped	8	5.4%
	Stopped at traffic light	5	3.4%
	Total	**148**	**100.0%**

Related to the safety behaviour of drivers before the time of a crash, information concerning three factors, such as alcohol consumption, talking on the mobile phone, and distraction was collected; 6.8% of drivers drank alcoholic beverages within 6 hours before a crash; 12.2% of drivers were talking on their mobile phone and 23.6% were distracted just before the crash occurred. Details are given in Table 4.22.

Table 4.22: Safety behaviour at the time of taxi crashes

Safety behaviour condition		Frequency	Percent
Alcohol consumed within 6 hours before crash	Yes	10	6.8%
	No	138	93.2%
	Total	**148**	**100.0%**
Talking on mobile phone	Yes	18	12.2%
	No	130	87.8%
	Total	**148**	**100.0%**
Distraction/inattention condition	Yes	35	23.6%
	No	113	76.4%
	Total	**148**	**100.0%**

4.2.1.3. Hospitalisation due to crashes and associated factors for taxi drivers in 12 month follow up

The most severe crashes are those incurring hospitalisation of the people involved; 59 (39.9%) of 148 crashes had at least 1 hospitalised person (either taxi drivers or other victims). Details are provided in Table 4.23.

Table 4.23: Hospitalised person(s) related to taxi crashes

Number of hospitalised persons	Frequency	Percent
0	89	60.1%
1	47	31.8%
2	12	8.1%
Total	**148**	**100.0%**

To find the pertinent risk factors in relation to the severity of taxi crashes, namely those RTCs resulting in hospitalised person(s), the binary logistic regression was applied to the binary outcome variable on hospitalised person(s) (1 = yes and 0 = no) with 11 environmental and temporal factors. Results of the analysis in Table 4.24

showed that 3 variables were significantly associated with the severity of a crash: time of crash, type of crash, and road alignment.

Crashes that occurred during rush hour (defined between 06:00 AM and 08:00 AM in the morning and 05:00 PM to 06:00 PM in the afternoon) were 2.24 times (95% CI: 1.00 to 5.03) more likely to result in hospitalised persons than crashes at any other times. In relation to type of crash, if a crash occurred between a taxi and a motorbike, it was 7.28 times (95% CI: 2.87 to 18.42) more likely to result in hospitalisation, when compared to other objects such as other cars, bicycles and pedestrians. Road alignment was also a risk factor related to the severity of crashes; crashes occurring on a curve or hillcrest roads were more likely to result in a hospitalised person by 2.68 times (95% CI: 1.00 to 6.80), compared to crashes happening on straight and level roads. Other factors such as weather, light conditions, lane changing, alcohol use and talking on a mobile phone were not statistically significant.

Table 4.24: Environmental/Temporal factors associated with hospitalised person(s) due to taxi crashes in 12 month follow up

Environmental factors		Crashes of taxi drivers		Statistic values			
		Total crashes	**Hospitalisation**	**Crude OR**	**Adjusted OR**	**95% CI**	**P value**
Day of crash	Weekend*	105	41 (39.0%)	1.24	1.39	0.57-3.43	0.46
	Weekday	43	18 (41.9%)				
	Total	**148**	**59**				
Time of crash	Non-rush hours*	78	23 (29.5%)	**2.53**	**2.24**	**1.00-5.03**	**0.04**
	Rush hours	70	36 (51.4%)				
	Total	**148**	**59**				
Type of crash	Taxi with other vehicles/other objects*	60	12 (20.0%)	**4.58**	**7.28**	**2.87-18.42**	**<0.01**
	Taxi with motorbikes	88	47 (53.4%)				
	Total	**148**	**59**				
Road alignment	Straight and level roads *	106	34 (32.1%)	**3.11**	**2.68**	**1.00-6.80**	**0.03**
	Curve/hillcrest roads	42	25 (59.5%)				
	Total	**148**	**59**				
Weather condition	Dry*	112	37 (33.0%)	3.18	1.97	0.74-5.25	0.17
	Wet	36	22 (61.1%)				
	Total	**148**	**59**				

Environmental factors		Crashes of taxi drivers		Statistic values			
		Total crashes	Hospitalisation	Crude OR	Adjusted OR	95% CI	P value
Light condition	Daylight*	92	34 (37.0%)	1.37	1.36	0.59-3.13	0.46
	Dawn/dusk/night time	56	25 (44.6%)				
	Total	**148**	**59**				
Changing the lane/merging	No*	68	20 (29.4%)	2.28	2.39	0.97-5.88	0.05
	Yes	80	38 (48.8%)				
	Total	**148**	**59**				
Had an alcoholic beverage within 6 hour before crash	No *	136	54 (39.7%)	1.08	1.19	0.27-5.17	0.81
	Yes	12	5 (41.7%)				
	Total	**148**	**59**				
Mobile phone used	No *	130	48 (36.9%)	2.68	2.68	0.76-9.42	0.12
	Yes	18	11 (61.1%)				
	Total	**148**	**59**				
Distraction/inattention	No distraction*	113	44 (38.9%)	1.17	1.04	0.38-2.88	0.92
	Have a distraction	35	15 (42.9%)				
	Total	**148**	**59**				

Environmental factors		Crashes of taxi drivers		Statistic values			
		Total crashes	**Hospitalisation**	**Crude OR**	**Adjusted OR**	**95% CI**	**P value**
Time of the year	Spring and Summer seasons*	79	28 (35.4%)	1.48	1.35	0.61-3.00	0.45
	Fall and Winter seasons	69	31 (44.9%)				
	Total	**148**	**59**				

**** Reference category***

4.2.2. Bus Driver Group

4.2.2.1. Crash incidence of bus drivers in 12 month follow up

During the 12 month follow up, 6 rounds of data collection were completed. Every 2 months, all drivers were contacted and asked about the history of any crashes within the last 2 months. Information about the change of job status, and loss to follow up were also documented. At the final stage of follow up, 10.7% of drivers had been lost to follow up. Among those with follow up, the proportion of drivers involved in crashes ranged from 0.8% to 7.9% within the six rounds. Details are shown in Figure 4.3.

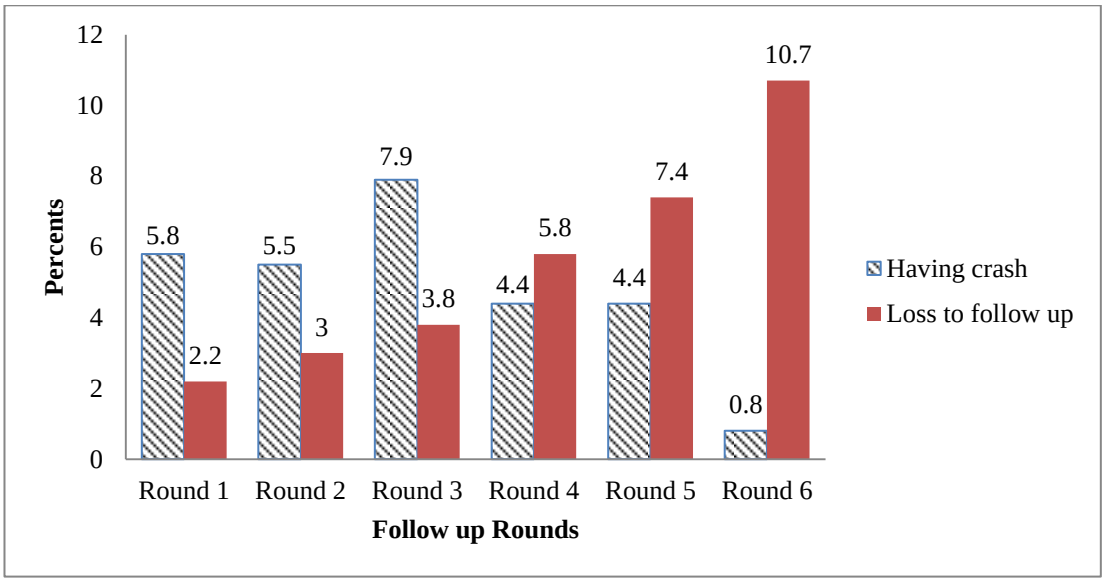

Figure 4.3: Percentage of having crashes and loss to follow up among bus drivers

Table 4.25 presents the distribution of crashes among bus drivers in 12 month follow up. Among the 365 bus drivers in the cohort, there were 109 drivers (29.9%) who had been involved in at least one RTC. A total of 111 crashes occurred in the 12 month follow up; only 2 drivers were involved in 2 crashes. The Cumulative Incidence was 0.304 in the 12 month follow up.

Table 4.25: Distribution of 111 crashes among 365 bus drivers

Frequency of crashes		Frequency	Percent
Number of crashes of each driver	0	256	70.1%
	1	107	29.3%
	2	2	0.5%
	Total	**365**	**100.0%**
Cumulative Incidence	**111/365 = 0.304**		

To find the influencing factors associated with RTCs for bus drivers in the follow up, binary logistic regression was performed between the binary dependent variable of having a crash and 11 demographic and behavioural variables. The results of regression analysis are presented in Table 4.26.

The duration of follow up (months) was used as the exposure variable in the logistic regression. Two significant factors were found: migrant workers, and perceived insufficient income to support family.

Drivers from other provinces, who migrated to work as bus drivers in Hanoi, were 1.89 times (95% CI: 1.08 to 3.33) more likely to be involved in a RTC compared to local drivers from Hanoi. In relation to income, if a driver perceived to earn insufficient money to support their family, they were 1.76 times (95% CI: 1.05 to 2.94) more likely to be involved in a RTC than other drivers, who reported otherwise.

Table 4.26: Factors associated with road traffic crash of bus drivers in 12 month follow up

Independent variables		Bus Drivers		Statistic values			
		Total drivers	**Crashed**	**Crude OR**	**Adjusted OR**	**95% CI**	**P value**
Age of drivers	Mean (SD)	39.2 (7.2)	37.9 (7.1)	0.96	0.96	0.92-1.01	0.11
Marital status	Not married*	44	10 (22.7%)	1.51	1.40	0.63-3.11	0.40
	Married	321	99 (30.8%)				
	Total	**365**	**109**				
Education levels: Highest grade completed	High school and above (grade 10-12 and above)*	301	84 (27.9%)	1.65	1.32	0.71-2.46	0.37
	Secondary school or less (grade 6-9 and below)	55	25 (39.1%)				
	Total	**365**	**109**				
Year of working as bus drivers	Mean (SD)	6.7 (4.6)	6.7 (4.8)	0.99	1.04	0.98-1.11	0.19
Migrant worker	Not migrant worker*	263	65 (24.7%)	**2.31**	**1.81**	**1.05-3.13**	**0.03**
	Migrant worker	102	44 (43.1%)				
	Total	**365**	**109**				
Sufficient income perceived	Sufficient*	233	56 (24.0%)	**2.12**	**1.77**	**1.07-2.93**	**0.02**
	Insufficient	132	53 (40.2%)				
	Total	**365**	**109**				
Alcohol consumed	No*	114	26 (22.8%)	1.67	1.37	0.76-2.33	0.31
	Yes	251	83 (33.1%)				
	Total	**365**	**109**				

Mobile phone used	No*	124	30 (24.2%)	1.53	1.55	0.92-2.61	0.09
	Yes	241	79 (32.8%)				
	Total	**365**	**109**				
Seat-belt used	Always*	37	11 (29.7%)				
	Sometimes	49	9 (18.4%)	0.53	0.52	0.18-1.48	0.22
	Seldom	88	24 (27.3%)	0.88	0.78	0.31-1.91	0.59
	Never	191	65 (34.0%)	1.22	0.85	0.37-1.95	0.71
	Total	**365**	**109**				
Suffered from tiredness	No*	63	23 (36.5%)	0.69	0.62	0.33-1.14	0.12
	Yes	302	86 (28.5%)				
	Total	**365**	**109**				
Infringement history	No*	280	81 (28.9%)	1.21	1.24	0.70-2.19	0.45
	Yes	85	28 (32.9%)				
	Total	**365**	**109**				

**** Reference category***

4.2.2.2. Crash characteristics of bus drivers in 12 month follow up

Figure 4.4 shows the time the crashes occurred. Time of crash happened from 05:00 AM to 11:00 PM. Most of the crashes occurred at rush hour from 07:00 AM to 08:00 AM and from 05:00 PM to 06:00 PM.

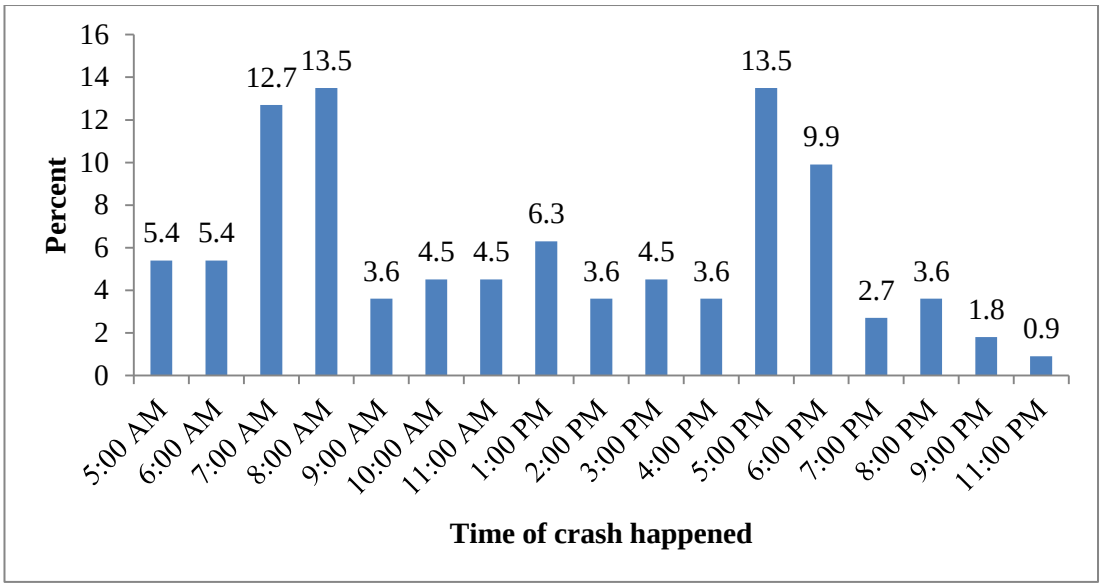

Figure 4.4: Time of crash among bus drivers

There is a high density of motorbikes in Hanoi, thus it was not surprising that 53.5% of all crashes were related to collisions between buses and motorbikes; about one third of crashes involved other cars, and only 3.6% of crashes involved pedestrians or bus passengers. Details are given in Table 4.27.

Table 4.27: Type of crashes among bus drivers during 12 month follow up

Vehicle/object	Frequency	Percent
Bus - Car	38	34.2%
Bus - Motorbike	59	53.2%
Bus - Bicycle	7	6.3%
Bus - Pedestrian/bus passenger	4	3.6%
Hit a tree/pavement	3	2.7%
Total	**111**	**100.0%**

As shown in Table 4.28, most of crashes (93.7%) occurred on local streets/roads. In relation to the gradient of roads, where crashes occurred, about half (47.7%) of crashes occurred in straight and level roads.

Table 4.28: Location and road alignment of bus crashes in 12 month follow up

Place and Road Gradient		Frequency	Percent
Location of crash	Highway	1	0.9%
	Street road	104	93.7%
	Company garage/final bus stop	6	5.4%
	Total	**111**	**100.0%**
Road alignment	Curve and grade/hillcrest roads	34	30.6%
	Curve and level graded roads	13	11.7%
	Straight and grade/hillcrest roads	11	9.9%
	Straight and level roads	53	47.7%
	Total	**111**	**100.0%**

Table 4.29 presents the distribution of crashes according to weather, light condition, traffic density, and bus movement. Of all crashes, 65.8% occurred in daylight and 68.5% of crashes happening in dry conditions. In respect to traffic density at the time of the crash, about half (54.1%) of crashes occurred on crowded road conditions. When asked about their driving actions just before the crash time, the dominant actions were changing lane (36%) and avoiding an object in the roadway (22.5%).

Table 4.29: Weather, light conditions and bus driving action before the time of a crash

Weather, light conditions and driving action		Frequency	Percent
Weather condition	Dry	76	68.5%
	Wet	35	31.5%
	Total	**111**	**100.0%**
Light condition at the time of crash	Dawn/dusk	25	22.5%
	Daylight	73	65.8%
	Night	13	11.7%
	Total	**111**	**100.0%**
Traffic density	Crowded road	60	54.1%
	Not crowded road	51	45.9%
	Total	**111**	**100.0%**
Bus movement	Avoiding object in roadway	25	22.5%
	Backing	6	5.4%
	Changing lanes	42	37.8%
	Going straight ahead	10	9.0%
	Leaving traffic lane	7	6.3%
	Making left/right turn	6	5.4%

	Merging	8	7.2%
	Parked/slowing or stopped	2	1.8%
	Stopped at traffic light	5	4.5%
	Total	**111**	**100.0%**

Table 4.30 presents the safety behaviour of drivers at the time of crash. Of bus drivers who crashed, 4.5% consumed alcohol within 6 hours prior to the crash, and among these five drivers, four had consumed 2 standard drinks, and one of them had consumed 3 standard drinks. The percentage of drivers talking on a mobile phone when a crash occurred was 4.5%. In relation to the distraction or inattention of drivers before the crash, 6.3% of crashed drivers reported that they were in a distracted state at the time of their crash.

Table 4.30: Safety behaviour at the time of bus crashes

Safety behaviour condition		Frequency	Percent
Alcohol consumed within 6 hours before the crash	Yes	5	4.5%
	No	106	95.5%
	Total	**111**	**100.0%**
Talking on mobile phone	Yes	5	4.5%
	No	106	94.5%
	Total	**111**	**100.0%**
Distraction/inattention condition	Yes	7	6.3%
	No	104	93.75
	Total	**111**	**100.0**

4.2.2.3. Hospitalisation due to crashes and associated factors for bus drivers in 12 month follow up

Table 4.31 presents the hospitalisation outcome of crashes. Of the 111 crashes, 36 crashes (32.4%) resulted in at least one hospitalised person (including either driver or other crash victims).

Table 4.31: Hospitalised person(s) related to bus crashes

Number of hospitalised persons	Frequency	Percent
0	75	67.6%
1	33	29.7%
2	3	2.7%
Total	**111**	**100.0%**

To find the pertinent risk factors in relation to the severity of the taxi crashes, namely those RTCs resulting in hospitalised person(s), binary logistic regression was applied

to the binary outcome variable on hospitalised person(s) (1 = yes and 0 = no) with 10 environmental and temporal factors. Results of the analysis in Table 4.32 showed that 2 variables were significantly associated with the severity of the crash, namely, type of crash, and weather condition at the time of crash.

A collision between a bus and motorbike was 6.65 times (95% CI: 2.20 to 20.16) more likely to result in a hospitalised person compared to other types of collisions such as cars, bicycles, and pedestrians. Weather condition was also a risk factor related to severity of crash. Crashes occurring in wet weather were 3.36 times more likely to have resulted in hospitalised person(s) (95% CI: 1.11 to 10.10), when compared to crashes occurring in dry weather. Both factors were found to be statistically significant after controlling for other environmental conditions and temporal variables.

Table 4.32: Environmental/Temporal factors associated with hospitalised person(s) due to bus crashes in 12 month follow up

Environmental factors		Crashes of Bus Drivers		Statistic values			
		Total crashes	Hospitalisation	Crude OR	Adjusted OR	95% CI	P value
Day of crash	Weekend*	26	22 (23.1%)	1.82	2.20	0.71-6.78	0.17
	Weekday	85	30 (35.3%)				
	Total	**111**	**36**				
Time of crash	Non-rush hours*	50	11 (22.0%)	2.46	2.68	0.96-7.48	0.05
	Rush hours	61	25 (41.0%)				
	Total	**111**	**36**				
Type of crash	Bus with other vehicles/other objects*	52	9 (17.3%)	**4.03**	**6.65**	**2.20-20.16**	**<0.01**
	Bus with motorbikes	59	27 (45.8%)				
	Total	**111**	**36**				
Road alignment	Straight and level roads *	53	14 (26.4%)	1.72	2.19	0.81-5.93	0.12
	Curve/hillcrest roads	58	22 (37.9%)				
	Total	**111**	**36**				
Weather condition	Dry*	35	8 (22.9%)	**1.97**	**3.36**	**1.11-10.10**	**0.03**
	Wet	76	28 (36.8%)				
	Total	**111**	**36**				

Environmental factors		Crashes of Bus Drivers		Statistic values			
		Total crashes	Hospitalisation	Crude OR	Adjusted OR	95% CI	P value
Light condition	Daylight*	73	25 (34.2%)	0.78	1.18	0.43-3.24	0.74
	Dawn/dusk/night time	38	11 (28.9%)				
	Total	**111**	**36**				
Changing the lane/merging	No*	17	5 (29.4%)	1.18	0.94	0.21-4.28	0.94
	Yes	94	31 (33.0%)				
	Total	**111**	**36**				
Mobile phone used	No*	106	34 (32.1%)	1.41	2.21	0.27-18.21	0.45
	Yes	5	2 (40%)				
	Total	**111**	**36**				
Distraction/inattention	No distraction*	104	33 (31.7%)	1.61	2.77	0.32-24.07	0.35
	Have a distraction	7	3 (42.9%)				
	Total	**111**	**36**				
Time of the year	Fall and Winter seasons*	73	22 (30.1%)	1.35	2.09	0.75-5.79	0.15
	Spring and Summer seasons	24	14 (36.8%)				
	Total	**111**	**36**				

**** Reference category***

Chapter 5: Discussion

Overview

This is the first study to examine in detail the prevalence, incidence and risk factors for RTC among bus and taxi drivers in Hanoi, Vietnam. The findings of the study are presented in comparison with the results of other studies within a global and Vietnamese context. Recommendations are made based on the findings of the study.

5.1. Taxi Drivers

5.1.1. Prevalence and Risk Factors for a Crash for Taxi drivers

The prevalence of RTC among the cohort of taxi drivers was 27.7% for the three-year retrospective study. The prevalence of crashes appears to vary between countries. For example, a study of taxi drivers in Sydney recorded 36 crashes among 41 drivers within the last two years (Dalziel & Job, 1997). Burns et al. (1995) reported a prevalence of 19% among taxi drivers, whereas a study on RTC among South African taxi drivers found that 33.8% of taxi drivers had been involved in a crash, with an average of 6.5 crashes during an average driving exposure of 10.1 years (Peltzer & Renner, 2003).

Among the 336 RTCs in the study, 27.7% resulted in a person(s) being hospitalised. The majority of these hospitalisations involved one person in the taxi, however, one RTC resulted in six persons requiring hospitalisation. Over half of RTCs (55.7%) occurred on local roads as opposed to freeways/highways or arterial roads. A plausible reason was that most taxis travel inside the city, with very few taxis undertaking long trips outside Hanoi. Our results were different from a study in urban China which found that 16.5% of crashes were at intersections or local roads (Zhuanglin et al., 2009).

Factors that significantly affected involvement in a crash for taxi drivers included age, the type of driving license, employment status, income perceived level, seat-belt usage and history of traffic infringements in the last 12 months. There was a negative

association between the age of the driver and involvement in a RTC. The mean age of taxi drivers in the crash and non-crash groups was different (30.4 versus 32.4 years, respectively). A study undertaken in South Africa found the age range of taxi drivers was between 20 to 62 years, with a mean age of 33.7 years (Peltzer & Renner, 2003). The mean age of taxi drivers in Israel was 42.5 years (SD = 10.6) and ranged from 24 to 65 years (Rosenbloom & Shahar, 2007). A study on RTCs among taxi drivers in New South Wales, Australia, did not find any significant association between the age of drivers and crashes (Lam, 2004). However, association between the age of taxi drivers and a RTC was found in another study (Claret et al., 2003).

Surprisingly, a taxi driver with a level B driving license was less likely to be involved in RTCs compared to a driver with a higher graded driving license. Vietnamese driving licenses are mandatory for all drivers of motor vehicles, as well as for riders of motorcycles with an engine capacity of over 50cc. For car driving licenses, there are six levels available in Vietnam: B1, B2, C, B, E, and F levels. As taxi drivers, they have to hold at least a B2 level. In our study, 64.5% of the taxi drivers held a B2 driving license. Level B is the first level for drivers with minimal driving experience. Taxi drivers, who held a higher level of driving license, had been previously employed as truck drivers (35.5%). These truck drivers might have been over confident and took more risks on the road whereas lower level license drivers were more likely to be overly cautious due to their lack of experience. Our results are different from Canada, where drivers with taxi driving license permit were less likely to be involved in RTCs than drivers possessing other driving license permits (Maag, et al., 1997).

Taxi drivers working in full-time employment as taxi drivers were also more likely to be involved in RTCs compared to those in part-time employment. In this study, most drivers (93.3%) were engaged in part-time casual employment. A possible explanation was that full-time employees work every day with few days off in a month, and thus had busy working schedules. This could lead to tiredness or ‘work-related burnout’. It appeared that not all drivers believed they had sufficient rest time, and experienced feelings of tiredness. The average sleeping time reported by taxi drivers was 6.7 (SD 1.7) hours. Tiredness has been suggested as a risk factor for a crash in previous research (Corfitsen, 1994, 1996, 2003). As indicated in a study on fatigue and crashes among taxi drivers in Australia, more than 11% of drivers with

long working hours have reported falling asleep when driving (Dalziel & Job, 1997). It also mentioned the relationship between fatigue and RTCs among taxi drivers; the drivers who have fallen asleep at the wheel at least once during their careers have higher crash rates than those who have not.

The income of taxi driver was also a significant factor for crash involvement. If the drivers did not earn sufficient money to support their families, they were more likely to be involved in RTCs, compared to other taxi drivers who perceived sufficient income. The average income per month of each driver was 3.7 million Vietnamese Dongs (approximately $2,200 USD per year), with little difference between the crashed group and the non-crashed group. It is possible that drivers who did not earn sufficient income to support their families were trying to attract more passengers to increase earning by working longer hours. This is consistent with the results of previous research. Indeed, a study on road traffic risk factors from Iran also found that social determinants, such as lack of insurance and low income, were related to risky driving as well as RTCs (Shams, Shojaeizadeh, Majdzadeh, Rashidian, & Montazeri, 2011). Another study in Israel indicated that low income drivers were more likely to be involved in RTCs (Factor, Mahalel, & Yair, 2008). Similarly, a study on taxi crashes in Australia reported that with insufficient income perceived, a preference for 'hunting' for work rather than waiting was indicative of a general predisposition of 'hard driving' amongst these taxi drivers. The reduced rest time may partly contribute to crash involvement through fatigue effects (Dalziel & Job, 1997). It is interesting to compare the net earnings of high risk drivers with a suitable control group to determine if there is much to be gained by high risk driving.

A history of traffic infringements in the past twelve months was positively associated with involvement in a crash (Burns & Wilde, 1995). Approximately, three quarters of taxi drivers had traffic infringements, who on average incurred 1.2 traffic violations. For comparison, over half (50.6%) of Chinese drivers reported at least one traffic violation in the past 12 months, with speeding, illegal parking and running red lights being the three most reported traffic violations (Huang, Zhang, Murphy, Shi, & Lin, 2011). The high number of traffic violations among the Vietnamese cohort of taxi drivers was due to the upgraded traffic regulations such as new restricted roads, new one-way road or new designated non-parking places.

Another significant factor for involvement in a crash among taxi drivers was seat-belt usage. Taxi drivers who never wore seat-belt were 1.69 times more likely to be involved in RTCs than drivers who always wore seat-belt when driving. Wearing a seat-belt is a very important passive intervention that ensures the safety of drivers in the event of a crash. National seat-belt wearing legislation came into effect in Vietnam in 2001, and was updated in 2008 (National Assembly of Vietnam, 2001). However, only half of the Vietnamese taxi drivers 'always' wore their seat-belts when driving. The study on seat-belt usage among taxi drivers in China showed that just over half (56.4%) of taxi drivers reported always wearing a seat-belt. However, a roadside observation in the same survey found that only 31.7% of the taxi drivers actually wore seat-belts (Routley, et al., 2009). A study undertaken in Boston showed that 17 out of 250 taxicab drivers (6.8%) always wore seat-belts, whereas 233 (93.2%) did not (Fernandez, Park, & Olshaker, 2005). Chinese taxi drivers estimated that they wore seat-belts for about 63% of the time (Huang, et al., 2011). A study of taxis in Beijing, China, observed that 19% of drivers wore seat-belt correctly, 47.2% did not wear a seat-belt, and 31.6% used seat-belt in a non-functional way (Fleiter, et al., 2009).

Reasons given by the Vietnamese taxi drivers for not always wearing seat-belt were: 'discomfort' (25.9%); 'frequent stops/inconvenient' (14.9%); 'feeling safe in vehicles' (9.6%). This is consistent with previous research (Blows et al., 2005; Babio & Daponte-Codina, 2006; Fleiter, et al., 2009; Huang, et al., 2011). In the Beijing study, it was noted that there might be 'no need' for taxi drivers to use a seat-belt (Fleiter, et al., 2009).

Some studies indicated a positive association between alcohol use and collision risks. In a study on alcohol and driving factors in collision risk, the likelihood of crash increased with self-reported drinking, OR = 1.51 (Mann et al., 2010), though statistically non-significant.

Finally, some studies mentioned other factors of RTCs for taxi drivers, such as gender, education levels, and marital status (Broyles, et al., 2003; World Health Organization, 2009; Mann, et al., 2010; Phong, 2010; Spoerri, Egger, & von Elm, 2011), but they were found to be non-significant in the current study.

5.1.2. Incidence and Risk Factors for a Crash Involvement of Taxi Drivers

The cohort of taxi drivers was followed every two months for a year to identify their RTC during this period. Loss to follow up among the taxi driver cohort was 18.5%, which is consistent with previous research (M.-R. Lin, Chang, Pai, & Keyl, 2003; Phillips, Pagano, Menard, & Stout, 2006; Weitoft, Hjern, Batljan, & Vinnerljung, 2008).

Among the final sample of 1214 taxi drivers, 145 drivers (11.9%) were involved in 148 crashes during the twelve months. Of the drivers involved in a crash 97.9% were involved in one crash, with only 2.1% (3 drivers) involved in two crashes. The incidence of crashes among this cohort of taxi drivers was greater than the number of crashes recoded in the previous 3 years. The differences in the magnitude of crashes may be due to the recall bias of drivers from the retrospective study (Pannucci & Wilkins, 2010). This may also explain the loss to follow up. Those drivers involved in crashes, especially more severe crashes, might change jobs or be discharged by the company. The incidence of involvement in a crash for the Vietnamese cohort was still lower than that in Canada, where 19.6% of taxi drivers reported one or more crashes (Burns & Wilde, 1995).

Our study also found that 39.9% of the 148 crashes had at least one person requiring hospitalisation as a result of the crash, which included either the taxi driver or the passenger(s). Approximately 8% of crashes had two or more persons requiring hospitalisation as a result of the crash. The Vietnamese rate was higher than that in New York City where 21% of taxi drivers or passengers were admitted to hospital due to a crash (Schaller, 2006).

When examining the risk factors for a hospitalisation crash, three factors were associated with an increased risk. They were: the time of the crash, nature of the crash, and the road alignment.

Crashes which took place during rush hour (06:00 AM - 08:00 AM and 05:00 PM – 06:00 PM), were 2.24 times more likely to lead to a serious injury. High frequency of crashes among the cohort of taxi drivers occurred during rush hours (about 10% of crashes). The results were similar to other studies on RTCs (Dissanayake & Lu, 2002; Yau, 2004; Zhuanglin, Chunfu, Hao, & Sheqiang, 2009).

A study in Hong Kong identified the day of the week and time of crash as important factors affecting the severity of the crash with less severe injuries usually occurred during the traditional office hours (from 08:00AM to 03:59 PM) (Yau, 2004). Moreover, crashes which took place during office hours reported fewer fatal or serious injury crashes (Dissanayake & Lu, 2002; Zhuanglin, et al., 2009). In relation to taxi crash severity in Vietnam, the high density of vehicles, especially the most vulnerable road users such as motorbikes and bicycles, contribute to the severe crashes (Phong, 2010). These people would be severely injured and hospitalised if involved in a crash. The results from a study on taxi drivers and road safety in Sydney, Australia, concluded that the pattern of RTC among taxi drivers varied by time of day, with the peak of RTC between 01:00 AM to 05:00 AM (Dalziel & Job, 1996).

Several studies suggested that inadequate visibility due to poor light conditions, may play a key role in RTCs during early morning or late evening (Mohan, et al., 2006). The study by Weninger and Hertz (2007) indicated that most of the crashes occurred between 03:00 PM and 09:00 PM. Analysis of the pattern of crashes related to the time of day, day of the week and by year suggested the crash peaks occurred at around 08:00 AM – 09:00 AM and 03:00 PM – 04:00 PM (Evans & Courtney, 1985). However, another study in Australia found that taxi crashes were fairly evenly distributed across day and night, and across different days of the week (Dalziel & Job, 1997).

Regarding the nature of the crash, a definite pattern emerged. If the crash involved a motorbike, the risk of hospitalisation as a result of the crash was 7 times higher than those involving other motor vehicles such as private cars or trucks. This may be due to the high density of motorbikes in Hanoi and motorcyclists were the most vulnerable road users in regard to severity of crashes (Department of Transport of Hanoi, 2011; Ministry of Transport of Vietnam, 2011). In our study taxi crashes with motorbike accounted for 59.5% of the crashes; 33.1% with other cars; and only 0.7% of crashes was due to collisions between taxis and pedestrians. The increasing exposure between cars and motorbikes is a problem in Vietnam which needs to be addressed (Phong, 2010). According to the Midterm Report on National Road Traffic Safety Strategies of Vietnam, most RTCs in Vietnam were caused by motorbikes (75%) rather than cars (17%) (Phong, 2010).

The alignment of the road was another risk factor for a serious injury crash. If the taxi crash occurred on the curve or hillcrest of the road, the risk doubled compared to crashes which occurred on straight or level roads, even though 71% of crashes occurred on a straight section of the road (Dissanayake & Lu, 2002). Zhuanglin et al. (2009) found that urban RTCs were more likely to occur on the curve of the road rather than a straight stretch of road (Zhuanglin, et al., 2009).

Finally, other factors such as weather conditions, light conditions, alcohol consumption, and mobile phone use, were not significant predictors for a serious injury crash.

5.2. Bus Drivers

5.2.1. Prevalence and Risk Factors for a Crash for Bus Drivers

The prevalence of crashes among bus drivers was 20% for our cohort of 365 bus drivers who were involved in 76 RTCs. In comparison to RTCs by other vehicles in Vietnam such as trucks, motorbikes and private cars, the prevalence for bus crashes was low (Phong, 2010; Department of Transport of Hanoi, 2011). A study on bus crashes in France found that 3.6% of traffic injury crashes in the community reported by the police were caused by buses (Brenac & Clabaux, 2005).

Many of the bus crashes (n=56, 73.7%) resulted in a hospitalisation indicating the severity of these crashes. This proportion was much higher than other studies on bus crashes. For example, Yang et al. (2009) found that 22.3% of bus crashes resulted in injury for an occupant of the bus. In France, RTCs involving a bus or coach accounted for 1.5% of all the injury crashes, and 1.6% of fatal crashes (Brenac & Clabaux, 2005).

Two factors significantly affected involvement in a crash and/or increased the frequency of crashes for bus drivers. They were type of workers (migrant workers) and income perceived level of the bus driver.

Bus drivers who migrated from other provinces to work in Hanoi were found to be 4.26 times more likely to be involved in RTCs, when compared with local drivers who are residents of Hanoi. Several studies have found that migrant drivers lived in in a stressful working environment with poor living conditions and financial struggle to take care of their families (Greiner, Krause, Ragland, & Fisher, 1998; Kompier,

Aust, van den Berg, & Siegrist, 2000). A study by Wahlberg (2007) on bus driver behaviour, found that stress was the main contributing factor for crash involvement. Furthermore, stressful traffic hazards such as poor driving conditions and erratic driving behaviour of other road users, added to the stress levels of bus drivers, especially if the bus drivers were not familiar with the areas on their route of travel. A study on road safety of unfamiliar drivers in Australia found similar result, which identified the risk of RTC for an unfamiliar driver is higher than that of native drivers, while the level of risk depends on the specific nature of the destination (Somasundaraswaran, 2010). Education programs related to improving local knowledge and work practices directed at migrant workers may help to reduce their crash risk.

In relation to income, if the bus drivers did not perceive to earn sufficient money to support their families, they were 2.6 times more likely to be involved in a RTC, compared to other drivers who felt they earned sufficient income. This finding is consistent with previous research (Mirza, et al., 1999; Strathman, et al., 2010). It is possible that many bus drivers had to find other jobs to earn extra money to support their families. This extra work has the potential to increase stress and fatigue when driving a bus (Mirza, et al., 1999). Moreover, an increased physical workload could be a cause of delayed responses in emergency situations for drivers (Boufous & Williamson, 2009).

5.2.2. Incidence and Risk Factors for a Crash Involvement of Bus Drivers

The cohort of bus drivers was also followed every two months for a year to determine their involvement in crashes during this period. At the end of the one year follow-up, among the 365 drivers, 109 drivers (29.9%) were involved in at least one RTC. Of the 109 bus drivers involved in a crash, 107 drivers (98.2%) were involved in one crash only. The results showed an increasing trend of RTCs among bus drivers when compared to the last three years in the retrospective study. This trend was similar to that in the USA, where the crash, injury and fatality rates increased by 171%, 37.8%, and 5.1% respectively, between 2003 and 2007 (Wachana, 2010).

Similar to the results of the retrospective study, the identified risk factors for a crash during the 12 month follow up period were type of workers (migrant workers) and income perceived level of the bus driver.

Bus drivers from other provinces of Vietnam who moved to work in Hanoi were almost two times more likely to be involved in RTCs, in comparison with local drivers. It is known that unfamiliar situations increase the risk level of RTC for all drivers, because the new environment encountered will create anxiety and stress beyond their comfort level (Somasundaraswaran, 2010). Our finding suggests that an appropriate intervention targeting bus drivers in unfamiliar surroundings would help to reduce the RTC.

In relation to income, for those bus drivers perceived insufficient money to support their families, they were almost two times more likely to be involved in RTCs than other drivers who felt they earned sufficient income. The finding is consistent with Factor et al. (2008) who found that low income drivers in Israel were more likely to be involved in RTCs.

About one third (32.4%) of the 111 bus crashes resulted in at least one hospitalisation (either drivers or other victims). A study on school bus and injury in USA mentioned that among their crashes, 87.7% had no injuries reported (Yang, et al., 2009). It appears difficult to determine the exact number of injuries as a result of a bus crash due to under-reporting (Brenac & Clabaux, 2005).

Two factors were found to be significantly associated with the severity of crashes, namely, nature (type) of crash, and weather condition at the time of crash. With respect to type of crash, if the crash was due to a collision between the bus and a motorbike, the risk of a hospitalisation was 6.65 times than other types of crash (such as car, bicycle or truck). There is a higher density of motorbikes in Hanoi and motorcyclists are known to be vulnerable with inflated crash risk (Phong, 2010). The situation in Vietnam is different from other countries. In a study investigating 2237 local bus crashes in Uppsala, Sweden, the percentage of local buses in collision with cars was 57%, with other local buses 8%, and with trucks 5%, whilst 16% were single-vehicle crashes (af Wåhlberg, 2004a; Albertsson & Falkmer, 2005). A study on mini bus crashes in Canada also indicated that 79% of crashes were multi-vehicle crashes (Hamed, et al., 1998).

A study on bus crashes in the USA concluded that an increase in traffic volume increased both the frequency and severity of bus crashes (Chimba, Sando, & Kwigizile, 2010), whereas a study on school buses found a pedestrian or bicyclist was most likely to be injured in crash caused by buses (Yang, et al., 2009). However, among all types of vehicle, crashes involving a vehicle and an object (such as a tree or a pole) were associated with more severe injuries than those involving multi-vehicles crashes (Boufous, Finch, Hayen, & Williamson, 2008).

Previous studies have suggested that environmental conditions such as weather is a risk factor for a serious injury crash (Albertsson & Falkmer, 2005). The results of our study also indicated that bus crashes which occurred in wet conditions, were almost four times more likely to result in hospitalisation when compared to crashes in dry weather conditions. Similarly, a study conducted in Sweden observed that 10% of all bus and coach casualties occurred in bad weather (Albertsson & Falkmer, 2005). However, a study in Portland, USA, did not find any association between weather condition and the severity of crash among buses. According to Strathman et al. (2010), environmental conditions had no impact on the frequency of a bus crash.

Other factors, such as time of crash, day of crash, light conditions, changing lanes when driving, alcohol consumption, talking on mobile phone, had little impact on the risk of a hospitalisation crash in Vietnam, even though they were identified as significant risk factors in other countries (Dissanayake & Lu, 2002; Yau, 2004; Zhuanglin, et al., 2009).

5.3. Limitations of Study

There are several limitations that need to be considered when interpreting the findings. For the retrospective study, the prevalence of RTCs was estimated from currently employed bus and taxi drivers. Information from drivers who left the profession prior to the survey was not captured in our database. Moreover, the possibility of recall bias based on self-reports cannot be ruled out. This phase of study adopted a cross sectional design, which meant that causality could not be implied. However, regression analyses do provide a useful way of gaining knowledge about the relative strength of relationships between variables, and the combined ability of various factors to relate to RTCs for bus and taxi drivers.

For the prospective study, new drivers who entered the profession were excluded in the follow up. Moreover, a 12 month follow up was used because of time and resource constraints. Tracking the cohort and loss to follow up posed a major difficulty due to the high turn-over of drivers.

The loss to follow up can be attributed to various reasons in the literature. These include the kind of incentives offered, inadequate communication with the subjects (Conwell et al., 2007), working status and the health problems or injuries of the cohort (Maraste, Persson, & Berntman, 2003; Garcia et al., 2005).

The information on risk factors of RTC among bus and taxi drivers was collected and analysed, but the root causes of risky behaviour and potential effective interventions were not explored. Further qualitative studies are required to provide recommendations and suggestions of safe driving practices for bus and taxi drivers.

The RTCs of buses and taxis were part of a complex traffic problem. These crashes were related to other road users such as private car drivers and passengers, motorcyclists, bicyclists, and pedestrians. There is a need to conduct a holistic study on RTCs involving bus and taxis in relation to other road user perspectives.

Another limitation was the lack of detailed information on the injury outcomes as a consequence of RTCs among bus and taxi drivers in Hanoi, for the past three years and also for the 12 month follow up period. The main reason was that drivers involved in severe crashes usually either changed their job or their employment was terminated.

Chapter 6: Conclusions and Recommendations

Overview

A summary of the key findings of the study are presented in this chapter. RTCs during the last three years and associated factors of crashes are summarized. Information on the incidence of RTCs and pertinent risk factors associated with severity of crashes in the 12 month follow up, are also presented. Based on the results of the study, recommendations for safe driving among taxi and bus drivers, as well as suggestions for future studies, are provided.

6.1. Summary

6.1.1. Taxi Driver Group

6.1.1.1. Retrospective Study

1214 taxi drivers were recruited for face-to-face interviews. All drivers were male; age of drivers ranged from 18 to 57 years old. More than half of the drivers were smokers. Drinking was considered a problem for taxi drivers, since two thirds of the drivers had consumed alcohol during the last month. Half of the drivers always wore a seat-belt when driving, and three fourths of drivers had been fined due to traffic violations.

In the last three years, of the 1214 drivers 276 had been involved in RTCs. The prevalence of RTCs was 27.7% for the period of three years. About one third of crashes resulted in hospitalisation person(s). There were only two crashes which involved three victims. Majority of crashes (55.7%) happened on street roads.

Logistic regression analysis resulted in six significant factors associated with a crash. The age of drivers was negatively associated with a crash. Five other factors namely: type of driving license, employment status, insufficient income perceived, frequency of wearing a seat-belt, and traffic infringement history were also affected the risk of crashes.

Poisson regression analysis of the number of crashes identified five statistically significant factors namely: age of drivers, type of driving license, insufficient income perceived, frequency of wearing a seat-belt, and traffic infringement history.

6.1.1.2. Prospective Study

After 12 month follow up. More than ten percent (11.9%) of drivers had been involved in at least one RTC. Majority of crash drivers (97.8%) had involved in one crash. Cumulative Incidence was 0.122 over 12 months.

The results obtained in logistic regression analysis, indicated that suffering from tiredness increased the risk of RTCs for taxi drivers in Hanoi.

More than half of RTCs were collisions between taxis and motorbikes. Up to 90% of crashes occurred on street roads, with most of them (71.6%) occurred on straight and level roads.

Two thirds of RTCs occurred in dry conditions. Most (62.2%) crashes occurred in daylight. 49.6% of crashes happened when the driver was changing/leaving the lane or making left/right turn or merging. Regarding safety behaviour of drivers before the time of crash, 6.8% of drivers drank alcoholic beverages within 6 hours before the crash, 12.2% were talking on their mobile phone, and 6.3% of drivers were distracted just before the crash. Also 59 of 148 crashes reported in at least one hospitalised person.

In exploring the factors of hospitalisation due to crashes within the 12 month follow up, logistic regression analysis indicated that crashes occurred in rush hours, crashes between taxis and motorbikes, and the road alignment at the place of a crash (crashes in curve or hillcrest roads) were positively associated with a hospitalisation crash.

6.1.2. Bus Driver Group

6.1.2.1. Retrospective study

All bus drivers in the study were men. The mean age of drivers was 39.2 years old.

Just over half (53.7%) of drivers were smokers. Over two third (68.8%) of drivers had drunk at least one standard drink in the last month before the time of interview. 66.0% of drivers had made a phone call when driving a bus. Only 10.2% of bus drivers always wore a seat-belt. The main reasons drivers gave for not always wearing seatbelts when driving was: discomfort; feeling safe in vehicle; did not

know there was a need to use one and inconvenience. But only 23.3% of bus drivers have been fined due to traffic violations.

In the last three years, 365 bus drivers had been involved in 76 RTCs. The prevalence of RTCs amongst bus drivers during a period of three years was 20.8%. 56 (73.7%) crashes resulted in hospitalised persons. Majority (80.8%) of crashes occurred on street or local roads.

Of the risk factors pertaining to crashes, only migrant workers and perceived insufficient income to support family were significant according to logistic regression analysis. Similarly, the type of workers and perceived insufficient income to support family was significantly associated with the crash frequency from Poisson regression analysis.

6.1.2.2. Prospective study

The proportion of drivers involved in crashes ranged from 0.8% to 7.9% depending on the calendar month. Among them, 109 bus drivers (29.9%) had been involved in at least one RTC. Among crash drivers, 96.4% of drivers had been involved in one crash; only two drivers were involved in two crashes. The Cumulative Incidence was 0.304 in 12 months.

The results indicated that drivers from other provinces migrated to work as bus drivers in Hanoi, were more likely to be involved in RTC. Insufficient income perceived was also a risk factor of RTCs among bus drivers.

Just over half (53.5%) of crashes were collisions between buses and motorbikes. Most of them (93.7%) occurred on street roads and 65.8% in daylight, 68.5% in dry conditions. Of crashes 37.8% were related to changing lanes. Of the 111 crashes among bus drivers, 30.4% resulted in hospitalised person(s) (accounting for either drivers or other crash victims), 2.7% of crashes had two hospitalised persons.

Results of the analysis on risk factors relating to the severity of a crash, indicated two significant factors namely: types of crash (crash of bus and motorbike) and weather conditions (wet weather).

6.2. Conclusions

In conclusion, there is relatively little research examining the risk of crashes for bus and taxi drivers, particularly in developing countries. This study provided important

information regarding the morbidity of injuries among bus and taxi drivers and associated risk factors for a motor vehicle crash in Hanoi, Vietnam. The results have provided a benchmark against which to measure whether the future situation in Vietnam deteriorates, stabilises or improves. Therefore this study not only provides current estimates of the magnitude of crashes for bus and taxi drivers, it also enables future trends to be assessed by replication of some or all of the methodology adopted in this research. This information is essential for targeting resources and public health interventions to reduce the burden of bus and taxi crashes in the Vietnamese community.

The results have identified risk factors for both bus and taxi drivers and have also shown that risk profiles differ by age and other relevant demographic and behavioural characteristics. There were likely differences in risk factors between retrospective and prospective studies because somewhat different outcomes were studied. The retrospective study focused on history of crashes, whereas, the prospective study investigated severity of crashes, namely hospitalization.

In developing a response to road crashes in Vietnam, different agencies and sectors of the public should be involved in prevention activities and programs should be tailored to suit these different population groups. Evaluation should also be an integral part of all programs so that lessons can be learnt and shared regarding what may and may not work in terms of preventing road crashes and subsequent poor health outcomes in Vietnam.

Based on the results of the study, recommendations are provided as well as suggestions for future studies.

6.3. Recommendations

- Further studies are recommended to confirm our findings, before developing interventions for safe driving practices among buses and taxis in Hanoi. Physical health outcomes may mediate the relationship between stress and crash outcomes. Studies on physical health of drivers and its association with crashes are needed.
- There is a need to conduct a qualitative survey to identify the root causes and perceptions of bus and taxi drivers in relation to the road traffic crashes and

intervention measures.

- Drivers working conditions should be further explored in relation to the level of workload, and the need to undertake extra work among drivers to provide sufficient income. The element of time pressure could impact on crashes for bus drivers.
- Details on risky practices and unsafe behaviours, including: speeding; driving off from bus stop or a pick point before passengers are safely seated; running red and amber traffic lights; drink driving; mobile phone usage; and smoking should be described in relation to root causes and to the level of crash risk.
- Consideration of traffic hazards encountered by bus and taxi drivers, such as poor climatic conditions, and erratic driving behaviour of other road users, especially for motorcyclist, further add to the demands of the driver. Therefore, the need to conduct further studies on risk factors of RTCs related to buses and taxis from the perspective of other road users is suggested.
- The identified risk factor of migrant bus drivers suggests special training campaign for new bus drivers, who came from other provinces, to get familiar with surroundings to help reduce the RTC related to buses.
- Finally, an intervention on safe driving practices should be targeted towards bus and taxi drivers in the future to improve the safety of these drivers taking other road users into consideration.

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Appendices

Appendix 1: Information Sheet and Consent Form

Curtin University **Hanoi School of Public Health**

BUS AND TAXI STUDY

PARTICIPANT INFORMATION SHEET

We would like to invite you to participate in this important BUS and TAXI study. Your contribution will assist us in identifying strategies for making your industry safer.

Study aims:

This study aims to investigate the morbidity and risk factors of road traffic crashes among bus and taxi drivers in Hanoi, Vietnam. The findings will help develop road safety strategies to reduce road traffic crashes and crash related injuries among bus and taxi drivers.

What the study involves:

Driver Survey

We would to obtain information from bus and taxi drivers. We are interested in several issues related to road safety, such as: your history of crash involvement, your health, lifestyle habits, and your working conditions (including shift work). The structured questionnaire will take about 30 minutes to complete.

Confidentiality

All information provided by you will be treated as strictly confidential. The information collected in the course of this study will not be released to your company or distributed in an identifiable form to a third party without your consent.

No details that could identify you or your employer will be recorded. The only exception occurs if you prefer to be interviewed by telephone at another time. In this case, we would record your first name and phone number and destroy these details (by shredding) after the phone interview. Your name and phone number will not be linked to your responses.

After you agree to participate, you will be assigned a unique Identification Number (ID). Only our research staff will know your ID. The computer database containing the information you provide will NOT show your name, company or address, but only your ID.

Important:

Once your questionnaire data have been recorded on our database, all identifying information about you (for example, name and age) will be permanently removed from the study records, including the questionnaire. This means that none of the material collected will have your name, address or driver's license on it and no-one, including the study team, will be able to tell who has participated in the study.

Your Rights:

Informed Consent

Your decision to participate in the study must be based on informed consent. That means you must be told about all the details relevant to your participation before you agree to take part. Your signature on the Consent Form means that you have read and understood these details, and that you are satisfied with the answers to any queries you have. You cannot be interviewed without signing the Consent Form.

Voluntary Participation

Taking part in this study is VOLUNTARY. Your driver's license is NOT conditional on your decision to participate.

Withdrawal of Consent

You are free to withdraw from the study at any time without any negative consequences. In particular, withdrawal from the study will not have any effect on your driver's license.

If you agree to participate, please:

- Read this Information Sheet and the Consent Form
- Sign both Consent Forms
- **Keep this Information Sheet and one copy of the signed Consent Form**
- Return one signed consent form to us
- If you are unable to participate in the interview now, but are willing for us to contact you at a more convenient time, please give us your contact details.

IF YOU WOULD LIKE TO OBTAIN MORE INFORMATION ABOUT THE STUDY, OR YOU WANT TO TALK TO SOMEONE ABOUT THE QUESTIONNAIRE, PLEASE CONTACT:

Mr. LA Ngoc Quang

Department of Epidemiology, Hanoi School of Public Health

138 Giangvo, Badinh, Hanoi

Telephone: 04-62662326, Mobile phone: 0913 569 350

Email: ngocquang.la@postgrad.curtin.edu.au or lnq@hsph.edu.vn

This information is for you to keep

Curtin University

Hanoi School of Public Health

BUS AND TAXI STUDY

CONSENT FORM

Please sign this consent form and return it to us

I _____ (given name) _____ (family name) have read the Information Sheet and understand the aims of the study, and what my rights are as a study participant. I am also satisfied with the answers to my queries about the study.

I acknowledge that I have the right to withdraw from the study at any time without any penalty or effect on my driver's license.

I understand that all details that will identify me will be permanently and irretrievably removed from all BUS AND TAXI study files and databases once my information has been recorded.

I understand that the information collected will not be released in an identifiable form to a third party without my written consent, except in the unlikely event that the research team is forced by the court to produce such information without reference to me for legal actions that the court deems to be appropriate.

I agree that the results of the study may be published, providing that I cannot be identified.

The research will be carried out according to the guidelines on *Ethical Conduct in Research Involving Humans* by the National Health & Medical Research Council.

I hereby freely agree to participate in the BUS AND TAXI Study and understand that I cannot be interviewed unless I have signed this consent form.

Signature:_____Date:_____/_____/_____

Appendix 2: Bus and Taxi Driver Road Traffic Crash Questionnaire

Curtin University **Hanoi School of Public Health**

BUS AND TAXI STUDY

Baseline Questionnaire

Bus/taxi driver and road traffic crash

Identification Information

I1	Interviewer name	.....		
I2	Date of completion of questionnaire	...../ ...../ ..... Day/Month/Year		
	Respondent Id Number/Cohort ID: **[Office use only]**	☐☐	☐☐	☐☐☐
		Bus/taxi Code	Company Code	Staff ID Code
	Consent			
I3	Consent has been read out to the respondent	Yes 01 No 02	☐☐ **If NO, read consent**	
I4	Written consent has been obtained	Yes 01 No 02	☐☐ **If NO, END**	
I5	Name of driver	.....		
I6	Name of company	.....		

Additional Information

I7	Contact phone number where possible (mobile phone or home phone)	.....
I8	Address of driver:	
I8a	*Commune/town name:*	.....
I10b	*District/Quarter name:*	.....
I10c	*Province name:*	.....

Note: Identification information I1 to I10 should be stored separately from questionnaire because it contains confidential information.

1 Core Demographic Information

No.	Question	Response	Code	Coding Column
C1	Sex *(Record Male/Female as observed)*	Male Female	01 ☐ 02 ☐	☐☐
C2	How old are you?	.....	Years	☐☐
C3	What is your marital status?	Never married	01 ☐	☐☐
		Married	02 ☐	
		Separated	03 ☐	
		Divorced	04 ☐	
		Widowed	05 ☐	
C4	What is the highest level of education you have completed?	No formal schooling	01 ☐	☐☐
		Primary school completed	02 ☐	
		Secondary school completed	03 ☐	
		High school completed	04 ☐	
		College/University completed	05 ☐	
		Post graduate degree	06 ☐	
C5	Are you migrant worker who is not registered to be resident in Hanoi?	Yes No	01 ☐ 02 ☐	
C6	Are you living with family/partners?	Yes No	01 ☐ 02 ☐	
C7	Do you have to support your family/dependants or not?	Yes No	01 ☐ 02 ☐	
Work History				
C8	What is your main occupation?	Bus driver	01 ☐	☐☐
		Taxi driver	02 ☐	
C9	How long have you been driving a bus/taxi only to earn a living?	.....years.....months		
C10	Are you:	Full time employment	01 ☐	☐☐
		Employment by year	02 ☐	
		Part-time time employment	03 ☐	
		Casual/Cooperation with company	04 ☐	
C11	Did you sign a written contract with the company or just verbal agreement?	Written contract Verbal agreement	01 ☐ 02 ☐	☐☐
C12	Does your company provide you with social insurance?	Yes No	01 ☐ 02 ☐	☐☐
C13	Does your company provide you with health insurance?	Yes No	01 ☐ 02 ☐	☐☐
C14	What type of driving license do you have?	**B1**	01 ☐	☐☐
		B2	02 ☐	
		C	03 ☐	
		D	04 ☐	
		E	05 ☐	
		F	06 ☐	
C15	What is the date you received your first driving license? (check in back of license)	...../...../..... DD/MM/YY		
C16	Did you get any additional training on driving before became bus/taxi driver?	Yes No	01 ☐ 02 ☐	☐☐

C17	How many kilometers do you travel related to your job as bus/taxi driver on average each day?	..... km		☐☐
C18	How many hours do you work per day?	..... hours		☐☐
C19	How many days do you work each week?	..... days		☐☐
C20	Do you do shift work?	Yes **C22** ← No	01 ☐ 02 ☐	☐☐
C21	What kind of shift do you usually work?	Day	01 ☐	☐☐
		Morning	02 ☐	
		Afternoon	03 ☐	
		Night	04 ☐	
C22	Besides occupation as a driver, do you have another job to earn living?	Yes No	01 ☐ 02 ☐	
C23	What is your income per month (salary, bonus, tips, others)	…… VND		
C24	Is your earning sufficient to support your and your family needs?	Yes No	01 ☐ 02 ☐	
C25	Do you think the company goals/objectives put you under pressure at the workplace?	Yes No	01 ☐ 02 ☐	

2. Road Traffic Crash in Last Three Years (03/2006-03/2009)

RC1	During the past three years, how often, if at all, were you involved in road traffic crash involving any kind of damage or injury to you or another person or vehicle while you were driving a bus/taxi (2006-2009)?	Yes: …….. crash(es)	01 ☐	☐☐
		No	02 ☐ -> **S1a**	
RC2a	How many crashes have you ever been involved in last three years with hospitalization of person?	..... crashes		☐☐
RC2b	How many crashes have you ever been involved in last three years with money loss above 300.000 VND?	..... crashes		☐☐

We are going to ask you for further details on each road traffic crash, in which you involved in. We are now starting with the most recent one!

	QUESTION	RESPONSE	Crashes				
			1	2	3	4	5
RC3	Date of this crash	***(Ex: 20/6/07)***	.....	.....	.....	.....	.....
RC4	Where did crash happen? ***(Single choice)***	Highway	☐	☐	☐	☐	☐
		Street road	☐	☐	☐	☐	☐
		Cross-intersection	☐	☐	☐	☐	☐
		Car stops, stations	☐	☐	☐	☐	☐
		Other	.....	.....	.....	.....	.....
RC5	Was this crash reported to the company?	Yes	☐	☐	☐	☐	☐
		No	☐	☐	☐	☐	☐
RC6a	Have you ever experienced injury which resulted loss of work for more than one day or need medical care due to this crash?	Yes	☐	☐	☐	☐	☐
		No	☐	☐	☐	☐	☐
RC7	Do these injuries still affect you in any way?	Yes	☐	☐	☐	☐	☐
		RC8 <----No	☐	☐	☐	☐	☐
RC7a	If Yes, please describe:		....	....	....	....	.....

RC8	What did you think the cause(s) of this crash? ***(Multiple choices)***	Distraction/inattention	☐	☐	☐	☐	☐
		Too fast condition	☐	☐	☐	☐	☐
		Fell asleep/fatigue	☐	☐	☐	☐	☐
		Not under proper control	☐	☐	☐	☐	☐
		Exceeded stated speed limit	☐	☐	☐	☐	☐
		Following too close	☐	☐	☐	☐	☐
		Overcorrecting/over steering	☐	☐	☐	☐	☐
		Fail to yield right of way	☐	☐	☐	☐	☐
		Disregard traffic control	☐	☐	☐	☐	☐
		Too crowded road	☐	☐	☐	☐	☐
		Alcohol involvement	☐	☐	☐	☐	☐
		Medicine involvement	☐	☐	☐	☐	☐
		Misjudge clearance	☐	☐	☐	☐	☐
		Talking on mobile phone	☐	☐	☐	☐	☐
		Drug involvement	☐	☐	☐	☐	☐
		Improper passing	☐	☐	☐	☐	☐
		Lost consciousness	☐	☐	☐	☐	☐
		Third party fault	☐	☐	☐	☐	☐
		None detected	☐	☐	☐	☐	☐
		Other.....	.....	.....	.....	.....	.....
		Do not remember	☐	☐	☐	☐	☐
RC9	How many victims have admitted to hospitals or clinics due to crashes (both drivers and other parties)?		.....	.....	.....	.....	.....
RC10	How much money have you spend for crash (in total money spent) (VND)?		.....	.....	.....	.....	.....

3 Lifestyle Factors

Now I am going to ask you some questions about different lifestyle habits. This includes things like smoking, drinking alcohol, and other habits. Let's start with smoking.

Smoking (Section S)

No.	Question	Response	Code	Coding Column
S1	Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes?	Yes No	01 ☐ 02 ☐-> **A1**	☐☐
S2	How many cigarettes do you smoke a day?	Less than 1 cigarettes	01 ☐	☐☐
		1-5 cigarettes	02 ☐	
		6-10 cigarettes	03 ☐	
		11-20 cigarettes	04 ☐	
		More than 20 cigarettes	05 ☐	

Alcohol Consumption (Section A)

The next questions ask about the consumption of alcohol.

A1	Have you consumed a drink that contains alcohol such as beer, wine, spirit, fermented cider within last month?	Yes No	01 ☐ 02 ☐ -> **M1**	☐☐
A2	In the last month, how frequently have you had at least one drink that contained alcohol? ***(Read responses)***	5 or more days a week	01 ☐	☐☐
		1-4 days per week	02 ☐	
		1-3 days a month	03 ☐	
		Less than once a month	04 ☐	
A3	On average, how many standard drinks of alcohol would you have on a drink time?	1-2	01 ☐	☐☐
		3-4	02 ☐	
		5-6	03 ☐	
		7-9	04 ☐	
		10 or more	05 ☐	

4. Behavioural Measurements

Mobile Phone Use (Section M)

The next questions ask about the mobile phone use.

M1	Do you have mobile phone?	Yes No	01 ☐ 02 ☐ -> **M4**	☐☐
M2	Do you use your mobile phone when you are driving bus/taxi?	Yes No	01 ☐ 02 ☐ -> **M4**	☐☐
M3	In the last month, how often did you use mobile phone when driving? ***(Read responses)***	Always	01 ☐	☐☐
		Usually	02 ☐	
		Sometimes	03 ☐	
		Seldom	04 ☐	
M4	Whether your company or security staff request you not to use mobile phone while driving?	Yes No	01 ☐ 02 ☐	
M5	Do you perceive that using mobile phone while driving can cause accident?	Yes No	01 ☐ 02 ☐ -> **SS1**	
M5a	If yes, why do you still use mobile phone while driving	…….		

Seat-belt Use and Speeding (Section SS)

The next questions ask about the seat-belt use and speeding related to your job as a bus/taxi driver.

SS1	How often do you wear seat-belt when driving your bus/taxi?	**Always**	01 ☐ -> **SS4**	☐☐
		Usually	02 ☐	
		About half the time	03 ☐	
		Rarely	04 ☐	
		Never	05 ☐	
SS2	What are the reasons you do not always wear seat-belt when driving your bus/taxi? ***(Multiple choices)***	Not safety conscious	01 ☐	☐☐
		Feel safe in vehicle	02 ☐	
		Discomfort	03 ☐	
		No/faulty seat-belt	04 ☐	
		Frequent stops/inconvenience	05 ☐	
		Don't know/not sure	06 ☐	
		Other.....	88 ☐	
SS3	In the last month, how often have you drive bus/taxi faster than the speed limited of the road? ***(Read responses)***	Always	01 ☐	☐☐
		Usually	02 ☐	
		Sometimes	03 ☐	
		Seldom	04 ☐	
		Never	05 ☐	
SS4	Does your company monitor your seat-belt wearing or not?	Yes No	01 ☐ 02 ☐	

Fatigue (Section F)

The next questions ask about the fatigue condition.

F1	How many hours sleep do you need to be well rested?	..... hrs		☐☐
F2	How much sleep do you get on average a day?	..... hrs		☐☐

F3	Do you ever suffer from tiredness while driving?	Yes No	01 ☐ 02 ☐ -> **F5**	☐☐
F3a	If, Yes, how often does it happen?	Rarely	01 ☐	☐☐
		Sometimes	02 ☐	
		Often	03 ☐	
		Very often	04 ☐	
F4	What contributes to your tiredness while driving?	.....		
F5	Have you ever taken any medications to help you sleep?	Yes No	01 ☐ 02 ☐ ->**F7**	☐☐
F5a	In the last month, how frequently have you taken at least one medication for sleeping?	.....		☐☐
F6	Have you ever taken any medications to help you stay awake?	Yes No	01 ☐ 02 ☐ -> **F7b**	☐☐
F6a	In the last month, how frequently have you taken at least one medication for staying awake while driving?	.....		☐☐
F7	Have you ever fallen asleep when driving during last year?	Yes No	01 ☐ 02 ☐	
F7b	How many times have you fallen asleep when driving during last year	…….. times		

Offence (Section TF)				
TF1	Have you ever been fined due to your traffic mistakes in last 12 months?	Yes **VC1** <----No	01 ☐ 02 ☐	☐☐
TF2	If Yes, what kind of mistakes? ***(Multiple choices)***	**Items**		**Times**
		Exceeded legal alcohol breath and blood limit	01 ☐	.....
		Talking on mobile phone	02 ☐	.....
		Not use seat-belt	03 ☐	.....
		Exceeded stated speed limit	04 ☐	.....
		Illegal parking and stopping	05 ☐	.....
		Disregard traffic control	06 ☐	.....
		Other.....	88 ☐	.....

5. Self-Reported Health Status

I am going to ask you some questions about your health.

HS1	When did you have your last medical examination?	Within last year	01 ☐	☐☐
		1-2 years ago	02 ☐	
		3 or more years ago	03 ☐	
		Never	04 ☐	
		I can't remember	88 ☐	
HS2	How would you rate your overall health today?	Excellent	01 ☐	☐☐
		Very Good	02 ☐	
		Good	03 ☐	
		Fair	04 ☐	
		Poor	05 ☐	
		No response	88 ☐	

6. Physical Measurements

Height and weight				Code
PM1	Height	(in Centimetres, float point number)	.....,.....	☐☐☐.☐
PM2	Weight	(in Kilograms, float point number)	.....,.....	☐☐☐.☐

THANK YOU FOR YOUR TIME AND CO-OPERATION!

Appendix 3: Surveillance Form of Bus/taxi Driver and Road Traffic Crash

Curtin University **Hanoi School of Public Health**

BUS AND TAXI STUDY

Surveillance form of bus and taxi driver on road traffic crash in follow up time

Identification Information			
1 Core Demographic Information			
Respondent Id Number/Cohort ID: [Office use only]	☐☐	☐☐	☐☐☐
	Bus/taxi Code	Company Code	Staff ID Code

Introduction:

We are from Hanoi School of Public Health and we are conducting the study on bus and taxi drivers about the road traffic crash and the related factors. The study will provide solutions for safety drivers of our city. We would like to talk with you about the crash happened to you recently when you worked as a driver for earning living.

Screening question:

SQ1	Have you involved in a crash during last two months?	**SQ2** ← Yes 01 ☐ **End of interview** ← No 02 ☐	☐☐
SQ1	How many crash have you involved in last two months?	……crash (es)	☐☐

Now we would like to ask you some information on the last crash

1	Crash Characteristics			
CC1	Date of crash (DD/MM/YY)		...../...../.....	
CC2	Day of crash *(Monday, ... Sunday)*		.....	
CC3	On the day of crash, at what time did you start working		…..…..…h…..…	
CC4	Time of crash *(24 hour format)*		…..…..…h…..…	
CC5	What is the type of crashes? *(Single choice)*	Car - Car	01 ☐	☐☐
		Car - Motorbike	02 ☐	
		Car - Bicycle	03 ☐	
		Car - Pedestrian	04 ☐	
		Hit a tree/pavement	05 ☐	
CC6	What was the type of road where the crash happened? *(Single choice)*	Highway	01 ☐	☐☐
		Street road	02 ☐	
		Other.....	88 ☐	
CC8	What was the gradient of the road where crash happened? *(Single choice)*	Curve and grade/hillcrest	01 ☐	☐☐
		Curve and level	02 ☐	
		Straight and grade/hillcrest	03 ☐	
		Straight and level	04 ☐	
		Other	88 ☐	
		Do not remember	99	
CC9	What was the weather condition at the time of crash?	Dry	01 ☐	☐☐
		Wet	02 ☐	
CC10	What was the light condition at the time of crash? *(Single choice)*	Dawn/dusk	01 ☐	☐☐
		Daylight	02 ☐	
		Night	03 ☐	
		Other.....	88 ☐	
		Do not remember	99 ☐	
CC11	What was your driving action before crash? *(Single choice)*	Avoiding object in roadway	01 ☐	☐☐
		Backing	02 ☐	
		Changing lanes	03 ☐	
		Going straight ahead	04 ☐	
		Leaving traffic lane	05 ☐	
		Making left/right turn	06 ☐	
		Merging	07 ☐	
		Parked/slowing or stopped	08 ☐	
		stopped in traffic light	09 ☐	
		Other/unknown	88 ☐	
CC12	Were you wearing a seat-belt at the time of crash?	Yes	01 ☐	☐☐
		No	02 ☐	
		Do not remember	99 ☐	
CC13	Did you exceed stated speed limit at the time of crash?	Yes	01 ☐	☐☐
		CC14 ←No	02 ☐	
		CC14 ←Do not remember	99 ☐	
CC13a	If Yes, how fast were you traveling?	.....		
CC14	Was it too crowded road?	Yes	01 ☐	☐☐
		No	02 ☐	
		Do not remember	99 ☐	
CC15	Could you describe your health status at the day this crash happened?	**CC17** ← Good health	01 ☐	☐☐
		Not good health	02 ☐	
		CC17 ←Do not remember	99 ☐	
CC15a	If not good health status, what is your main health problem?	Insomnia	01 ☐	☐☐
		Dizzy	02 ☐	
		feeling depressed	03 ☐	
		anxiety	04 ☐	
		Other health problem……	88 ☐	
CC16	6 hours previous to the crash, did you have an alcoholic beverage?	Yes	01 ☐	☐☐
		CC17 ←No	02 ☐	
		CC17 ←Do not remember	99 ☐	

CC16a	If yes, how many drinks did you have?	..... number of drinks		
CC17	Did you take any medicine at least 30 minutes before to the crash?	Yes	01 ☐	☐☐
		CC18 ←No	02 ☐	
		CC18 ←Do not remember	99 ☐	
CC17a	If yes, what was/were the medicine(s) you took?	.....		
CC18	Were you talking on mobile phone with driving at the time of crash?	Yes	01 ☐	☐☐
		No	02 ☐	
		Do not remember	99 ☐	
CC19	Have any distraction/inattention that may have affected you right before crash?	Yes	01 ☐	
		CC20 ← No	02 ☐	
		CC20 ← Do not remember	99 ☐	
CC19a	What was the distraction?	.....		
CC20	Were you smoking while driving at the time of crash?	Yes	01 ☐	☐☐
		No	02 ☐	
		Do not remember	99 ☐	
CC21	In the 24 hours before the crash, did you use any drugs?	Yes	01 ☐	☐☐
		CC22 ←No	02 ☐	
		CC22 ←Do not remember	99 ☐	
CC21a	Which drug did you take at that time?	…….…….		
CC22	How many passengers did you carry on that trip?	..... passengers		☐☐
CC23	Was your crash attended by the police?	Yes	01 ☐	☐☐
		No	02 ☐	
2	**Injury Outcomes (IO section)**			
IO1	How many injured persons were in that crash?	..... persons		☐☐
IO2	How many injured persons were your passengers?	..... persons		☐☐
IO3	Were you injured in the crash?	Yes	01 ☐	☐☐
		IO5 ← No	02 ☐	
IO4	Injured parts: *(Multiple choices)*			
	1. Head	2. Face	3. Neck	4. Spinal	5. Chest
	6. Abdomen	7. Upper extremities	8. Lower extremities	9. Multiple injuries	99. Unknown
IO5	Mental status after crash:			
	1. Conscious	2. Lost/regained consciousness	3. Unconscious	99. Unknown
IO6	Final health condition results due to crash of driver:			
	1. Treated and discharged at a hospital/clinic	2. Minor surgery/Plaster	3. Died	
	4. Other			
IO7	Economic lost due to crash?			
	Expenditures for health problems:	……		
	Repaired the car:	……		
	Compensated for victim(s):	……		
	Other costs:	……		
3	**What do you think was the main reason to your crash? (MR section)**			
MR1	External causes:			
MR1a	Cause 1: ……			
MR1b	Cause 2: ……			
MR2	Your own problems:			
MR2a	Problem 1: ……			
MR2b	Problem 2: ……			
MR3b	Problem 3: ……			

THANK YOU FOR YOUR TIME AND CO-OPERATION!

Appendix 4: Post Survey Form of Bus/taxi Driver on Road Traffic Crash

Curtin University **Hanoi School of Public Health**

BUS AND TAXI STUDY

Post Survey Questionnaire on Bus/taxi driver and road traffic crash

I1	Interviewer name	.....		
I2	Date of completion of questionnaire	...../ ...../ ..... Day/Month/Year		
Respondent Id Number/Cohort ID: **[Office use only]**		☐☐	☐☐	☐☐☐
		Bus/taxi Code	Company Code	Staff ID Code
	Consent			
I5	Name of driver	.....		
I6	Name of company	.....		

1	**Core Demographic Information**			
C17	How many kilometers do you travel related to your job as bus/taxi driver on average each day?	..... km		☐☐

2	**Lifestyle Factors**

Now I am going to ask you some questions about different lifestyle habits. This includes things like smoking, drinking alcohol, and other habits. Let's start with smoking.

Smoking (Section S)

No.	Question	Response	Code	Coding Column
S1	Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes?	Yes No	01 ☐ 02 ☐-> **A1**	☐☐
S2	How many cigarettes do you smoke a day?	Less than 1 cigarettes	01 ☐	☐☐
		1-5 cigarettes	02 ☐	
		6-10 cigarettes	03 ☐	

		11-20 cigarettes	04 ☐	
		More than 20 cigarettes	05 ☐	
Alcohol Consumption (Section A)				
The next questions ask about the consumption of alcohol.				
A1	Have you consumed a drink that contains alcohol such as beer, wine, spirit, fermented cider within last year?	Yes No	01 ☐ 02 ☐ -> **M1**	☐☐
A2	In the last month, how frequently have you had at least one drink that contained alcohol? ***(Read responses)***	5 or more days a week	01 ☐	☐☐
		1-4 days per week	02 ☐	
		1-3 days a month	03 ☐	
		Less than once a month	04 ☐	
A3	On average, how many standard drinks of alcohol would you have on a drink time?	1-2	01 ☐	☐☐
		3-4	02 ☐	
		5-6	03 ☐	
		7-9	04 ☐	
		10 or more	05 ☐	

3. Behavioural Measurements

Mobile Phone Use (Section M)				
The next questions ask about the mobile phone use.				
M1	Do you have mobile phone?	Yes No	01 ☐ 02 ☐ -> **SS1**	☐☐
M2	Do you use your mobile phone when you are driving bus/taxi?	Yes No	01 ☐ 02 ☐ -> **SS1**	☐☐
M3	In the last month, how often did you use mobile phone when driving? ***(Read responses)***	Always	01 ☐	☐☐
		Usually	02 ☐	
		Sometimes	03 ☐	
		Seldom	04 ☐	
		Never	05 ☐	
Seat-belt Use and Speeding (Section SS)				
The next questions ask about the seat-belt use and speeding related to your job as a bus/taxi driver.				
SS1	How often do you wear seat-belt when driving your bus/taxi?	**Always**	01 ☐ -> **F1**	☐☐
		Usually	02 ☐	
		About half the time	03 ☐	
		Rarely	04 ☐	
		Never	05 ☐	
SS2	Does your company monitor your seat-belt wearing or not?	Yes No	01 ☐ 02 ☐	
SS3	What are the reasons you do not always wear seat-belt when driving your bus/taxi? ***(Multiple choices)***	Not safety conscious	01 ☐	☐☐
		Feel safe in vehicle	02 ☐	
		Discomfort	03 ☐	
		No/faulty seat-belt	04 ☐	

		Frequent stops/inconvenience	05 ☐	
		Don't know/not sure	06 ☐	
		Other.....	88 ☐	
SS4	In the last month, how often have you drive bus/taxi faster than the speed limited of the road? ***(Read responses)***	Always	01 ☐	☐☐
		Usually	02 ☐	
		Sometimes	03 ☐	
		Seldom	04 ☐	
		Never	05 ☐	
Fatigue (Section F)				
The next questions ask about the fatigue condition.				
F1	How many hours sleep do you need to be well rested?	..... hrs		☐☐
F2	How much sleep do you get on average a day?	..... hrs		☐☐
F3	Do you ever suffer from tiredness while driving?	Yes No	01 ☐ 02 ☐ **-> F6**	☐☐
F3a	If, Yes, how often does it happen?	Rarely	01 ☐	☐☐
		Sometimes	02 ☐	
		Often	03 ☐	
		Very often	04 ☐	
		All the time	05 ☐	
F5	Have you ever taken any medications to help you sleep?	Yes No	01 ☐ 02 ☐ **->F7**	☐☐
F5a	In the last month, how frequently have you taken at least one medication for sleeping?	.....		☐☐
F6	Have you ever taken any medications to help you stay awake?	Yes No	01 ☐ 02 ☐ **-> F7b**	☐☐
F6a	In the last month, how frequently have you taken at least one medication for staying awake while driving?	.....		☐☐
F7	Have you ever fallen asleep when driving during last year?	Yes No	01 ☐ 02 ☐	
F7b	How many times have you fallen asleep when driving during last year	…….. times		

Offence (Section TF)				
TF1	Have you ever been fined due to your traffic mistakes in last 12 months?	Yes **HS2** <----No	01 ☐ 02 ☐	☐☐
TF2	If Yes, what kind of mistakes? ***(Multiple choices)***	**Items**		**Times**
		Exceeded legal alcohol breath and blood limit	01 ☐	.....
		Talking on mobile phone	02 ☐	.....
		Not use seat-belt	03 ☐	.....
		Exceeded stated speed limit	04 ☐	.....

		Illegal parking and stopping	05 ☐	.....
		Disregard traffic control	06 ☐	.....
		Other.....	88 ☐	.....

4. Self-Reported Health Status

I am going to ask you question about your health.

HS2	How would you rate your overall health today?	Excellent	01 ☐	☐☐
		Very Good	02 ☐	
		Good	03 ☐	
		Fair	04 ☐	
		Poor	05 ☐	
		No response	88 ☐	

THANK YOU FOR YOUR TIME AND CO-OPERATION!