Structure Analysis of Latent Psychological Factors of Transportation Behaviour

交通挙動の潜在的心理要因に関する構造分析

by

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Abstract

In developing countries, the fast growing population, urban development and economic growth have recently caused many serious transportation problems throughout the countries. The lack of public transportation system and the increasing of number of vehicle in traffic stream which leads to the serious social problems through traffic accident and congestion are still the hot issue to be concerned with. The global status report on road safety done by world health organization in 2010 has showed the trend of road fatality of Asian countries especially ASEAN countries and Japan. It is found that the trend of road fatality of Cambodia, Indonesia, Myanmar and Laos have being increased remarkably from 2001 to 2010 whereas the other countries have being slightly decreased.

As for Cambodia after recovering from the civil war, Cambodia has spent many years of hard working to restore and build the transportation infrastructures under the assistance and equipment from other countries. Even though most of infrastructures, road safety action plans, traffic management and other countermeasures have been upgrading and applying into the transportation system but still many traffic accidents, congestion, violation and other serious issues occurred. The traffic accidents, congestion and violation were mostly caused by the road users and their travel behaviour and also the lack of public transportation in urban area.

To cope with the traffic issues, the government has been doing the cooperation with national and internal organizations and other related institutions such as Japan International Cooperation Agency (JICA), Handicap international, Japan External Trade Organization (JETRO), SYSTRA and other institutions and organizations to make and revise the transportation master plan, improve transportation infrastructures and facilities, conduct studies and traffic surveys, develop countermeasures, strategies and policies in order to improve the traffic situation and make people's life better. To increase the mobility, the urban rail transportation system has been planned and proposed as a high priority project in future master plan 2020. However, to what extent the existing commuters would patronize such a system is unknown. In addition, the underlying psychological factors that could induce more public transportation are not well understand.

Moreover, the soft solutions such as road users' perception or psychological factors, which are one of effective solutions to solve transportation issues, are not much considered in developing countries. Therefore, the study on latent psychological factors toward transportation behaviour is quite necessary. The latent psychological factors which influence to transportation behaviour such as road users' behavioural intention towards new modes of future urban public transport and their perception towards riskiness of traffic accident, their attitudes towards various risky driving behaviour such as drunk driving, distraction driving, speeding driving, careless driving and other forms of risky driving will be studied.

This dissertation identifies the latent psychological factors that influence transportation behaviour such as commuters' behavioural intention, their perception of future urban public transportation, drivers' perception towards riskiness of traffic accident and attitudes towards various risky driving behaviour such as drunk driving, distraction driving, speeding driving, careless driving and other forms of risky driving. (1) Extend the theory of planned behaviour (TPB) by including latent psychological factors. (2) Identify psychological factors of the commuter's behavioural intention toward future urban transportation system. (3) Identify psychological factors of drivers' perception toward risky driving behaviours. (4) Establish the numerical procedure in structural equation modelling (SEM) for stable and reliable results.

The dissertation is organised into eight chapters including the bibliographies and appendices. Chapter 1, introduction, presents the general background of traffic situation in developing countries and in Cambodia, the problem statement, research objective, scope of study and dissertation overview. In chapter 2, the literatures associated with the background of Phnom Penh city, current traffic situation and the future transportation planning are viewed. The special consideration is paid to the drivers' behaviour, application of theory of planned behaviour (TPB) and structural equation modelling (SEM) into the travel behaviour to investigate the road users' behavioural intention and drivers' attitudes toward perceived risk of accident. Chapter 3, research methodology, describes the theory of planned behaviour (TPB), TPB questionnaire design, structural equation modelling (SEM), and some numerical analysis problems in SEM. Chapter 4, data collection, describes the questionnaire surveys and the data collection. The questionnaire surveys have been done three times. The first and the second questionnaire survey

are used to observe commuters' behavioural intention toward future urban rail usage and the third questionnaire survey is designed to observe drivers' attitude toward risky driving behaviours. Chapter 5, research framework, describes the advanced modification of TPB models, framework and the proposed numerical procedure for stable result in SEM. Chapter 6, results for public transport, shows the descriptive statistics of respondents' profile, their attitudes and behavioural intention towards future urban rail, results of SEM models and the discussion of each models. Chapter 7, results for traffic safety, shows the descriptive statistic results of survey data, drivers' attitudes toward risky driving behaviours, result of SEM model and the discussion. Finally, chapter 8, conclusion and recommendations. The overall conclusion, research contributions and recommendations are discussed.

In conclusion, the present study demonstrates the latent psychological factors which should be aimed at in order to change the transportation behaviour. To the author's knowledge, this study is the early study regarding the latent psychological factors that could affect the transportation behaviour in developing countries. The results from structural equation models reveal that the commuter's behavioural intention towards future urban rail usage should be considered on their attitudes, subjective norm, perceived behavioural control, moral obligation, and awareness of consequences, attitudinal aspect variables, socioeconomic variable and travel characteristics. And the perceived risk of traffic accident is significantly influenced from drivers' perception and their attitudes to risky behaviours such as drunk driving, careless driving, distraction driving, driver's awareness such as lack of punishment awareness, and awareness of distraction driving.

The strategies to induce road users to use public transport such as urban rail should be aimed to the latent psychological factors including attitudes, subjective norm, perceived behavioural control, moral obligation, awareness of consequences, attitudinal aspects variable, socioeconomic variable and travel characteristics. By changing these latent psychological factors of the commuters, the behavioural intention towards future urban rail transport usage will also be changed. Therefore, the government or relevant institutions should also consider on these latent psychological factors in order to success. The results from the structural models suggest the transport operators or planners should be more concern about the quality service, comfort, convenience of public transport since the users are currently

experience with the poor public transport service and these issues have not been taken care. In term of subjective norm, transportation planner or investors should consider the effects of relatives or important person of commuters since this group of people also have influence on the commuters' decision to use future urban rail transit. In term of travel characteristic variable, the behavioural intention of using future public transport does not depend on whether the respondents own the driving license. In term of perceived behavioural control, moral obligation and awareness of consequences, transportation planners should provide campaign or advertisement to road users to know about urban rail system and its advantage. The actual behavioural intention towards future urban rail usage is yet to be investigated. Contribution of the results from the present study is hoped to shed some light on future urban rail in terms of travel demand. In addition, the analysis results can be additionally used for future research and study on transportation planning in order to induce the commuters to use more public transportation.

Moreover, the results from structural models of drivers' attitude also can suggests some strategies to reduce traffic accident in Cambodia. The increasing the drivers' attitudes, awareness and other psychological factors may be reasonable to reduce the traffic accident and violation. For example; in term of lack of law awareness, the government or relevant institutions should seriously consider of reinforcing, revising the traffic law and making it much more severe, broadcasting the countermeasures, traffic rules and others information about crashes or fatality of drinking driving in order to increase drivers' awareness and also to reduce the riskiness of traffic accident. As for lack of safety awareness, traffic polices or relevant officers should consider the educational and safety countermeasures of drunk driving to road users by broadcasting through the campaign, TV program or radio program. Doing so could make road users more understand and also increase their knowledge and safety awareness of drinking driving. Beside the improvement of road facilities, considering on enforcement and educational measure of drivers and their awareness are very important.

Table of Contents

List of Figures

List of Tables

Chapter 1

Introduction

Located in South-eastern Asia and known as Kingdom of Cambodia, Cambodia is a country which is home to more than 15 million people with the total land area of 181,035 square kilometres, 25 provinces including the capital and bordered by Thailand to the northwest, Laos to the northeast, Vietnam to the east and the Gulf of Thailand to the southwest. With tropical monsoons' climate and two seasons: rainy and dry season, Cambodia is known as an agricultural country which has the main products such as rice, rubber, corn, vegetables, cashews, cassava and silk (CIA, 2013). Regarding to the transportation, the whole transportation system such as roadway, railway, airway and waterway were severely damaged during the civil war. However, with assistance and equipment from other countries Cambodia has been upgrading the transportation infrastructures and most are massively improved. On the other hand, traffic problems such as road traffic accident, traffic congestion, traffic violation, lack of public transportation and others are denoted as a serious and hot issues to be concerned with.

1.1 Background

In developing countries, the fast growing population, urban development and economic growth have recently caused many serious transportation problems throughout the countries. The lack of public transportation system and the increasing of number of vehicle in traffic stream which leads to the serious social problems through traffic accident and congestion are still the hot issue to be concerned with. The global status report on road safety done by world health organization in 2010 has showed the trend of road fatality of Asian countries especially ASEAN countries and Japan. It is found that the trend of road

fatality of Cambodia, Indonesia, Myanmar and Laos have being increased remarkably from 2001 to 2010 whereas the other countries have being slightly decreased (See Figure 1-1).

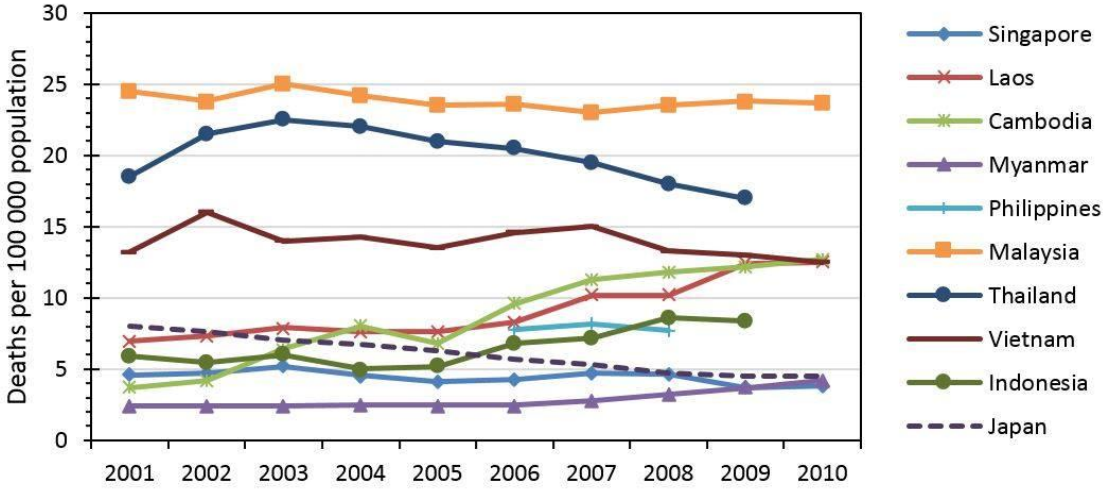


Figure 1-1: Trend of road fatality by country 2001-2010 - source WHO, 2010

As for Cambodia, after recovering from the civil war Cambodia has spent many years of hard working to restore and build in the transportation infrastructures under the assistance and equipment from other countries. The traffic issues have become worse and have contributed to the social problems. Even though most of infrastructures, road safety action plans, traffic management and other countermeasures were upgraded and applied into the transportation system but still many traffic accident, congestion, violation and other serious issues occurred.

The report of Cambodian Road Crashes and Victim Information System in 2012 had been showed that about 329 million US$ have been lost in road crashes with the increase rate about 6 percent compared to the cost in 2011. From 2005 to 2012, Cambodia had 9 fatalities per 10,000 registered vehicles, a number higher than Laos (6.9) and Vietnam (2.4). The fatality rate per 100,000 inhabitants in Cambodia was 13.4, which was higher than in Vietnam (10.7) but lower than in Laos (13.5). Over the last 8 years, the number of fatalities has doubled. At the same time, the population has increased by 11 percent and the number of registered vehicles has risen by 27.80 percent; more than 80% of all registered vehicles were motorbikes (NRSC and RCVIS, 2012). The critical point is that about 50 percent of fatalities are

adults who are between 15 and 29 years old and children under 15 years old accounted for 8% of the fatalities. Approximately 86 percent of the total number of fatalities are motorbike rider, followed by pedestrians (11%) and those travelling by family cars (8%) in 2012. Generally, human errors contributed to 96 percent of crashes and fatalities, while vehicle defects accounted for 2.8 percent and road environment and weather for 1.2 percent (RCVIS, 2010).

The lack of road user discipline, inadequate regulations, poor use of traffic management measures, and low levels of enforcement are particular problems and greatly reduce the effective capacity of the road systems, especially during morning and evening peak hours. Beside these, the road users themselves are the main factor which involves in traffic violation, congestion and accident. The traffic accidents and violations were often occurred by the drivers who were driving in bad manner or risky behaviour such as high speed driving, drinking driving, dangerous overtaking, changing lane or direction and driving without respecting right of way. Moreover, the lack of urban public transportation system running in city is also one of issues which contribute to the severe traffic condition.

Recently, in 2012 government and Japan International Cooperation Agency (JICA) have been working on the project for comprehensive urban transport plan in capital city. The objectives of this project are to formulate a comprehensive urban transportation plan for Phnom Penh city targeting 2035 including short-term plan (2016) and mid-term plan (2020), conduct a pre-feasibility study on the priority projects, strengthen and improve the implementation capacity of the urban transport-related agencies (JICA, 2012). Based on the future master plan in 2020 reported by Japanese External Trade Organization (JETRO), road transportation and the development of public transportation system in city was planned to support the decentralized urban structure (4 inner cities) with 2.2 million population. The future public transportation system, rail transit and bus transport system, will be introduced inside the urban area not only inner city but also sub-cores. There will be 3 main lines of urban transports system and public bus system running in Phnom Penh city. The urban rail systems are designed to link traffic from the suburban cores to the downtown. Roads will be improved to have a specific lane for cars, motorcycles and pedestrians.

Given the aforementioned traffic issues, the transportation behaviour (see Figure 1-2) including transportation system, human factor, road factor, automobile, environment, law system and other factors is getting worsen even though transportation infrastructures, transportation facilities, traffic safety and traffic management and other countermeasures have been built and applied. Moreover, an insufficient urban transportation system, traffic accidents and road users' behaviour are serious issue to be more concerned. In this regards, studies about the transportation planning, safety, and road users' behaviour which can suggest policies, strategies and countermeasures, should be conducted in order to improve traffic situation in developing countries.

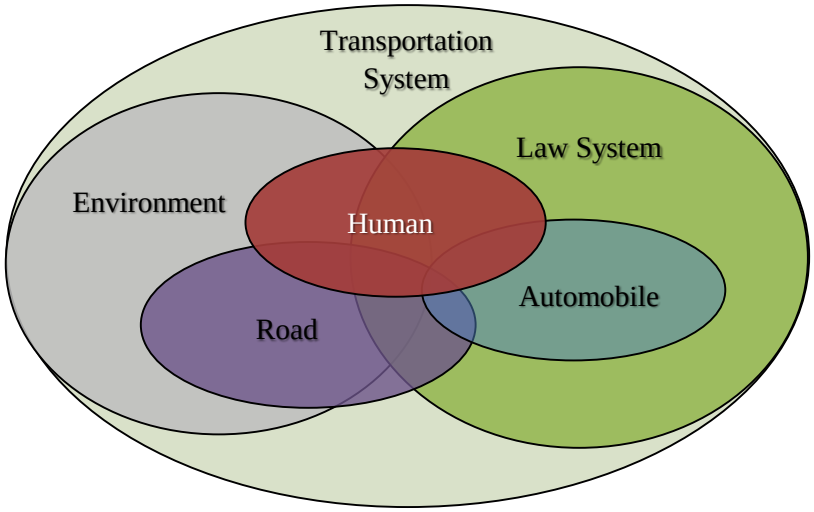


Figure 1-2: Key components of transportation behaviour

1.2 Statement of Problem

The background confirms the serious situation of traffic issues in developing countries especially in Cambodia, and its future urban transportation master plan in capital city. The traffic condition has gradually worsen day by day. Traffic violation, accidents and the number of fatalities have been increasing year by year. The human factor shares the highest proportion of causing traffic accident which is about 95 percent following by vehicle and road environment (See Figure 1-3). Most of traffic accidents are caused by drivers' behaviour which are related to various risky behaviours such as high speed driving, drunk driving, careless driving, dangerous overtaking, changing direction and lane, driving without helmet, driving without obeying traffic laws and so on.

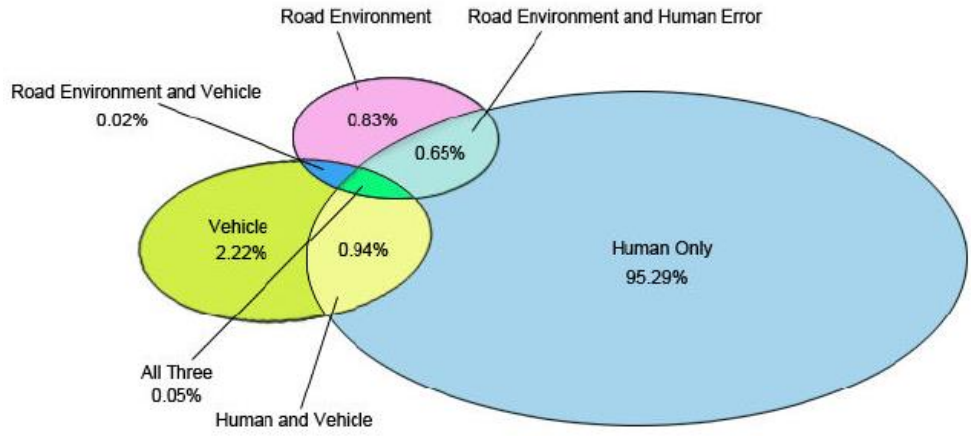


Figure 1-3: Percentage of crashes by cause of crashes - source RCVIS, 2010

Figure 1-4 shows the percentage of crashes and fatalities by type of crashes. Over speed driving represented about 49 percent of crashes and more than 50 percent of fatalities, while others 13 percent of crashes and 16 percent of fatalities were cause by drunk driving. Drunk driving is a growing issue and is the big concern for road safety. Dangerous overtaking also contributed to a high proportion about 8 percent for both of crashes and fatalities (RCVIS, 2010).

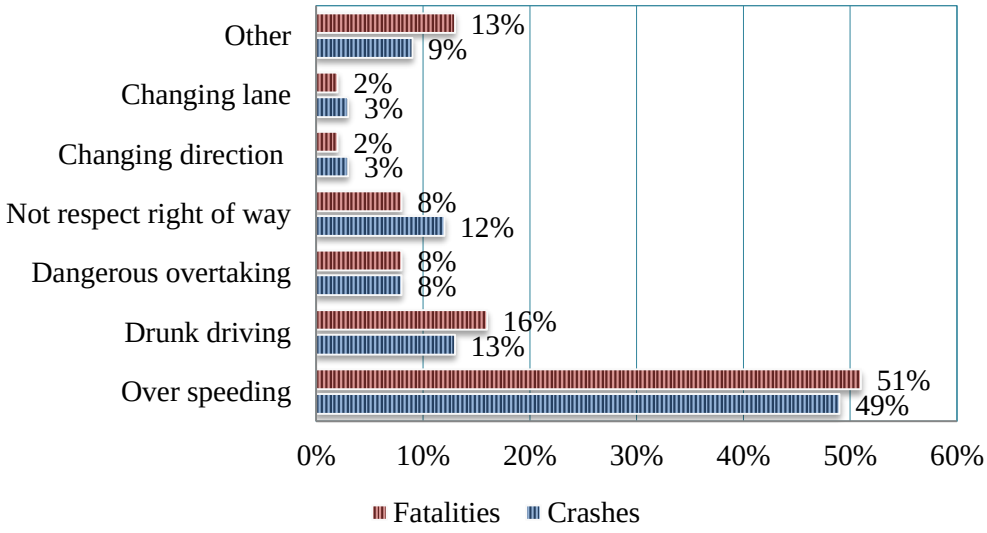


Figure 1-4: Percentage of crashes and fatalities by type of crashes

The other traffic problems were pointed out by Japan International Cooperation Agency (JICA) such as problem of traffic management, which caused traffic congestion, high numbers of traffic accidents and air pollution. The traffic problems were caused by drivers, especially motorcycles drivers have recently

been considered one of the most serious issues. An improper public transportation system is regarded as the main reason for the increasing number of vehicles. The deteriorated road condition and inappropriate road facilities, which lead to traffic concentration on the major roads and finally cause traffic congestion. The urban sprawl and development and population growth have led the travel demand exceeded the available supply and caused traffic congestion, which in turn reduces economic activities and increase transportation costs.

To deal with the traffic issues, the government had been doing the cooperation with national and internal organisations and other related institutions such Japan International Cooperation Agency (JICA), Handicap international, JETRO, SYSTRA and other institutions and organisations to make or revise the transportation master plan, improve transportation infrastructures and facilities, collect traffic data, conduct studies, develop countermeasures, strategies and policies in order to improve the traffic situation and make people's life better. Likewise in 2001, with the cooperation between the municipality of Phnom Penh and JICA the first intra-city bus service was operated in Phnom Penh city. It was operated for a short period about one month after that the operation was postponed. It was considered an experiment operation in order to identify the potential effects of bus service in city, to collect data for estimating the demand for bus service, to find out the problems to be solved for smooth operation of bus service in the city, and to help the citizens in city understand the merits of the bus system (JICA, 2001). Since then, still there is no intra-bus city service running in city. The urban public transport is still a hot issue and one of reasons for the increasing number of vehicle and traffic congestion in city. With this failure of testing and application of public bus service, it is very important to investigate and understand the road users' travel behaviour towards public transportation.

Also in 2007, the Municipality of Phnom Penh (MPP) and JICA conducted a "Project for traffic improvement in Phnom Penh City" (PTIPP) to improve urban traffic condition by reducing traffic congestion and traffic accident through the implementation of appropriate traffic management by applying 3Es policy which including the intersection improvement (E1: Engineering), traffic safety education to drivers (E2: Education) and traffic enforcement by traffic police (E3: Enforcement) (PTIPP, 2009). Even though, the transportation facilities, countermeasures, safety policies and enforcement had

been improved and applied, the traffic problems such as accident, congestion and violation still occurred. Especially, the number of accidents and fatalities had been increasing every years. Two of the important constituents of a transportation system are drivers and passengers. An understanding of some of the transport users' characteristics and behaviour of drivers and passengers is essential for the design or development of transportation facilities, safety, and prevention and planning.

Moreover to increase the mobility, the urban rail transportation system has been planned and proposed as a high priority project. Based on the future master plan in 2020 reported by JETRO, the municipality of Phnom Penh with assistance of the government of Japan and France for the ongoing city planning project was planning to operate the urban rail transit system in Phnom Penh city in order to increase mobility within city. However, to what extent the existing commuters would patronize such a system is unknown. In addition, the underlying psychological factors that could induce more public transportation are not well understand. Therefore, investigation of road users' intention and other psychological factors that can help explain the possibility of using this future urban rail transport is very essential. And the expected results will be useful for understanding the road users' current behaviour and can give ideas on the feasibility of such an investment.

Given abovementioned review, the current traffic problems in city and its transportation future plan are viewed. Several solutions, cooperation, studies, experiments, countermeasures, improvement of transportation infrastructure and facilities and other safety action plans had been done and applied but still the transportation behaviour is not much improvement. The traffic accidents, congestion and violation were mostly caused by the road users and their travel behaviour and also the lack of public transportation in urban area. It is observed that transportation planners and engineers have been working hard to deal the transportation issue with hardware solutions. However, the software solutions such as psychological factors is also very important to consider. Therefore, the study on latent psychological factors toward transportation behaviour is quite necessary. The latent psychological factors which influence to transportation behaviour such as road users' behavioural intention towards new modes of future urban public transport and their perception towards riskiness of traffic accident, their attitudes

towards various risky driving behaviour such as drunk driving, distraction driving, speeding driving, careless driving and other forms of risky driving will be studied.

1.3 Research Objectives

Study on the structure analysis of latent psychological factors of transportation behaviour especially Cambodian road users' behaviour which is the ultimate goal of this dissertation. The following objectives are defined:

- Extend the theory of planned behaviour (TPB) by including latent psychological factors.

- Identify psychological factors of the commuters' behavioural intention toward future urban transportation system. It includes the investigation of several aspects including socioeconomic variables and psychological factors that can potentially help to explain the likelihood of future urban rail transit's usage.

- Identify psychological factors of drivers' perception toward risky driving behaviours. It includes the investigation of drivers' attitudes to risky driving behaviours such as speeding driving, drunk driving, distraction driving, careless driving and other forms of risky driving which may influence to drivers' perception and cause the traffic accident.

- Establish the numerical procedure in structural equation modelling (SEM) for stable results. It includes the investigation on the numerical analysis problems in structural equation modelling, the development of SEM program, the proposed calculation procedure and criteria to be considered when applying SEM.

1.4 Scope of Work

In this dissertation, the scope of study will be limited to road users in Phnom Penh city, Cambodia. The road users who travel along the study line and study area will be interviewed or asked to complete the questionnaire surveys.

Regarding to the future urban rail transport's study, the commuters who travel along the urban rail's line linking the Central market in CBD to Phnom Penh international airport will be asked to participate in the questionnaire survey. The target respondents are limited to only motorcycle users both private and public users due to the fact that this group of users represent the highest proportion in the traffic stream and they are more likely to shift their travel mode to the proposed urban rail, compared with other road users such as private car users.

Whereas the study about the drivers' attitude towards the perceived risk of traffic accident, the drivers who stopped at a set of traffic light along roads, gas stations, universities, working offices or other places in Phnom Penh city are asked to participate in the questionnaire survey.

1.5 Dissertation Overview

This dissertation is organised into eight chapters including the bibliographies and appendices. The contents of each chapter are presented as follow.

Chapter 1 presents the general background of traffic situation in developing countries and in Cambodia, problem statement, research objective, scope of study and dissertation overview.

In chapter 2, the literatures associated with the background of Phnom Penh city, current traffic situation in city, the future transportation planning in city are reviewed. The special consideration is paid to road users' behaviour, application of theory of planned behaviour (TPB) and structural equation modelling

into the transportation behaviour to investigate the road users' behavioural intention and drivers' attitudes towards perceived risk of accident.

Chapter 3, research methodology, describes the theory of planned behaviour (TPB), TPB questionnaire design, structural equation modelling (SEM), and some numerical problems in SEM.

Chapter 4, data collection, describes the questionnaire surveys and the data collection. The questionnaire surveys have been done three times. The first and the second questionnaire survey are used to observe commuters' behavioural intention toward future urban rail usage and the third questionnaire survey is designed to observe drivers' attitude toward risky driving behaviours.

Chapter 5, research framework, describes the advanced modification of TPB models, framework and the proposed numerical procedure for stable result in SEM.

Chapter 6, results for public transport, shows the descriptive statistics results of respondents' profile, their attitudes, their behavioural intention towards future urban rail, the results of SEM models and the discussion of each models.

In Chapter 7, results for traffic safety, shows the descriptive statistics of the survey data, the drivers' attitudes toward risky driving behaviours, results of SEM analysis models and the discussions.

In Chapter 8, conclusion and recommendations. The overall conclusions, research contributions and recommendations are discussed.

Chapter 2

Literature Review

This chapter reviews the traffic situation in city and the existing literatures on users' intention and drivers' attitudes, perceptions and relevant issues in the context of this research. Section 2.1 reviews the general background of Phnom Penh city. Section 2.2 overviews the current traffic situation in city. Section 2.3 summarizes the future urban transportation planning in city. Section 2.4 reviews the previous studies on urban rail transit and the existing studies of road users' attitudes, behavioural intention towards future public transport, and their perception towards traffic accident and risky driving behaviours.

2.1 General Background of Phnom Penh City

Phnom Penh, the capital city of Cambodia, situates at the intersection of the four rivers, namely, upstream Mekong, Tonle Sab, Tonle Bassac, and downstream Mekong. With this specific geography, Phnom Penh is the centre of tourism, commerce, industry, politics, education, culture, history, diplomacy and communication of the country. The four rivers provide potential freshwater and river ecosystem as important resources for sustainable environment condition, beauty of nature and prosperous culture. Phnom Penh city was first built in the 15th century during King Ponhea Yat time. The population of Phnom Penh is about 1.55 million people (CIA, 2013) and will reach about 2.45 million people in 2030 (SYSTRA, 2012). Since December 2012, the municipality is subdivided into 9 administrative districts, 96 communes, 897 villages and therefore extended over 378 km^2 to reach 678 km^2 (See Figure 2-1). The city is structured around an historical centre whose characteristics are high density and mixed land use. Phnom Penh developed itself within the boundaries of 4 central districts, the area protected from

floods by the internal dykes and is extending to the immediate outskirts to form a homogenous urban fabric where dwelling area mixed with small business units, small tailor shops, small industries, or vicinity administrations.

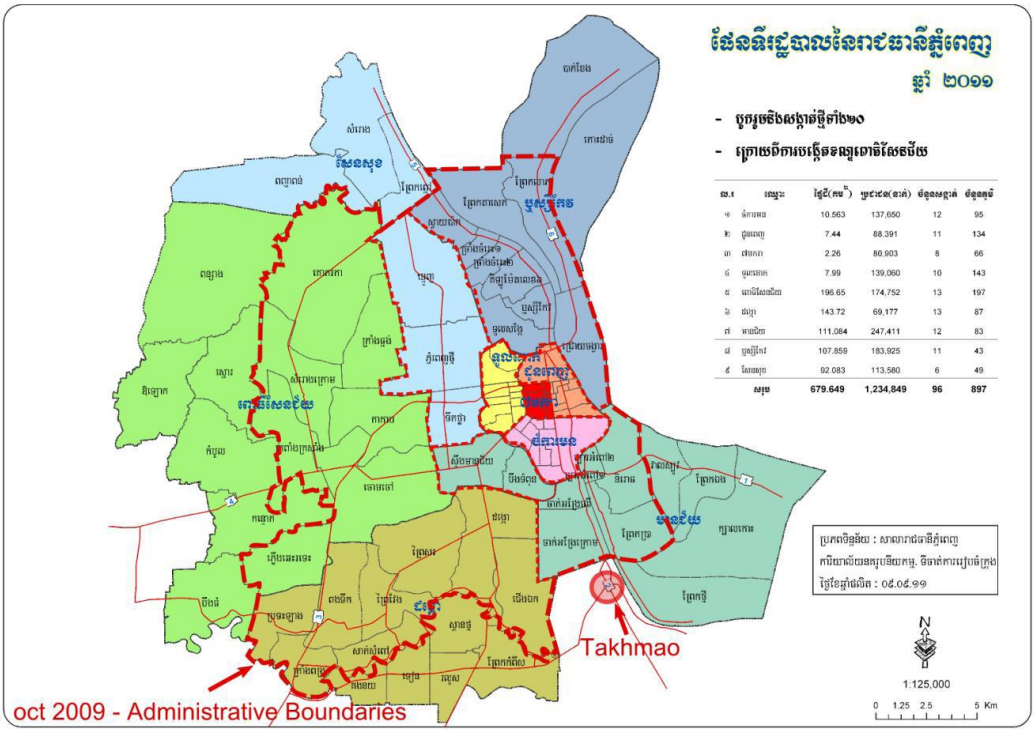


Figure 2-1: The boundaries of Municipality of Phnom Penh in 2009 and 2011- SYSTRA, 2012

The average density is not very high (3,300 inhabitants per km^2) but reaches 24,000 inhabitants per km^2 in the 4 historical districts which is very dense and higher than other cities in Southeast Asia. Density of Phnom Penh is a real asset when aiming at organizing a public transport system and to become a low consuming city in terms of energy (SYSTRA, 2012). The main economy is based on commercial interests such as garments, trading, and small and medium enterprises. Tourism is also a major contributor in the capital as more shopping and commercial centres open, making Phnom Penh one of the major tourist destinations. The GDP per capita in 2010 was about 2491 USD and was estimated to reach about 3170 USD in 2020. The average household income is about 492 USD per month and transports represent an average of 9 percent of monthly household income. In 2009, 86 percent of the households in city owned a motorcycle and 20 percent owned a private car (SYSTRA, 2012). These rates are relatively high compared to household's income.

2.2 Current Traffic Situation in City

2.2.1 Road Network

Road network is considered a basic infrastructure supporting a transport system. Roads network in Phnom Penh city are well-connected but roads in suburban areas have many missing links and the networks are incomplete. Some road sections are inundated and become impassable in the rainy season. Some geometric forms of road intersection, especially arterial roads, are not favourable to the existing number of vehicles passing through and also the existing ring roads have become inner ring roads due to city development and expansion (See Figure 2-2). Whereas the paved condition of major roads is not always good and traffic congestion sometimes can occur not only because of the increase traffic volume but also because of flooded road especially during rainy season. Currently, Phnom Penh metropolitan area's road system is getting structured to face the urban development.

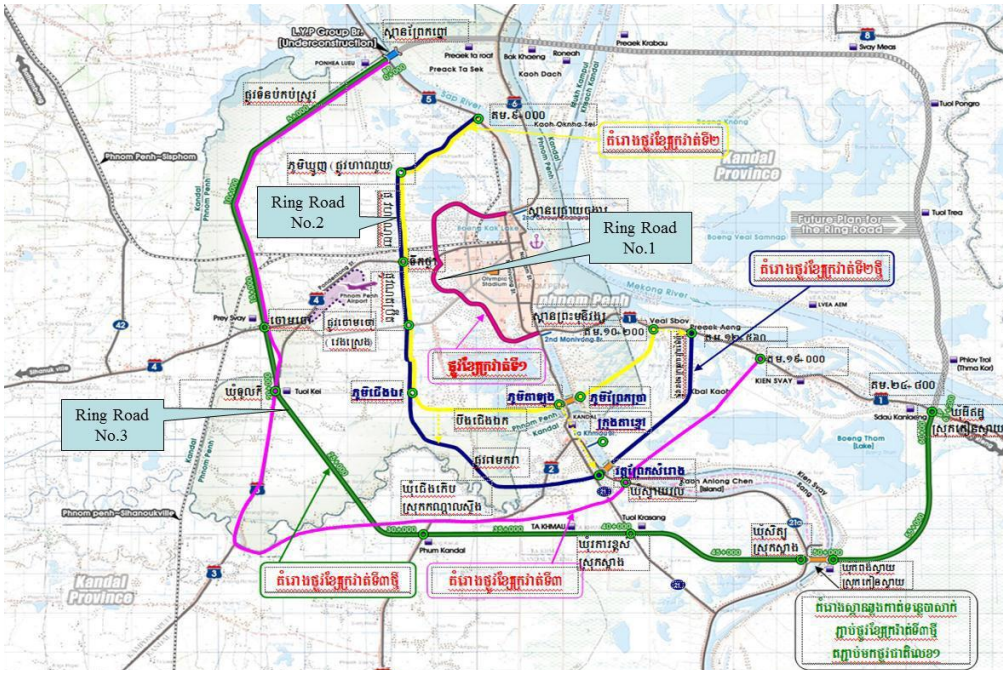


Figure 2-2: Proposed Phnom Penh city ring roads – source SYSTRA, 2012

The 4 central districts road network is now completed with a clear structure, including radial main arterials (extension of National roads) toward the central market and circular avenues with the shape of characteristics of arterials. The network is completed by collectors and small streets in a very dens grids

(See Figure 2-3). The 4 central districts are not concerned by major infrastructure projects. Thus, the different accesses towards the 4 central districts have main road infrastructure such as flyovers. Another new flyover is under construction at Mean Chey Bridge. This will be an issue for implementing the public transport systems.

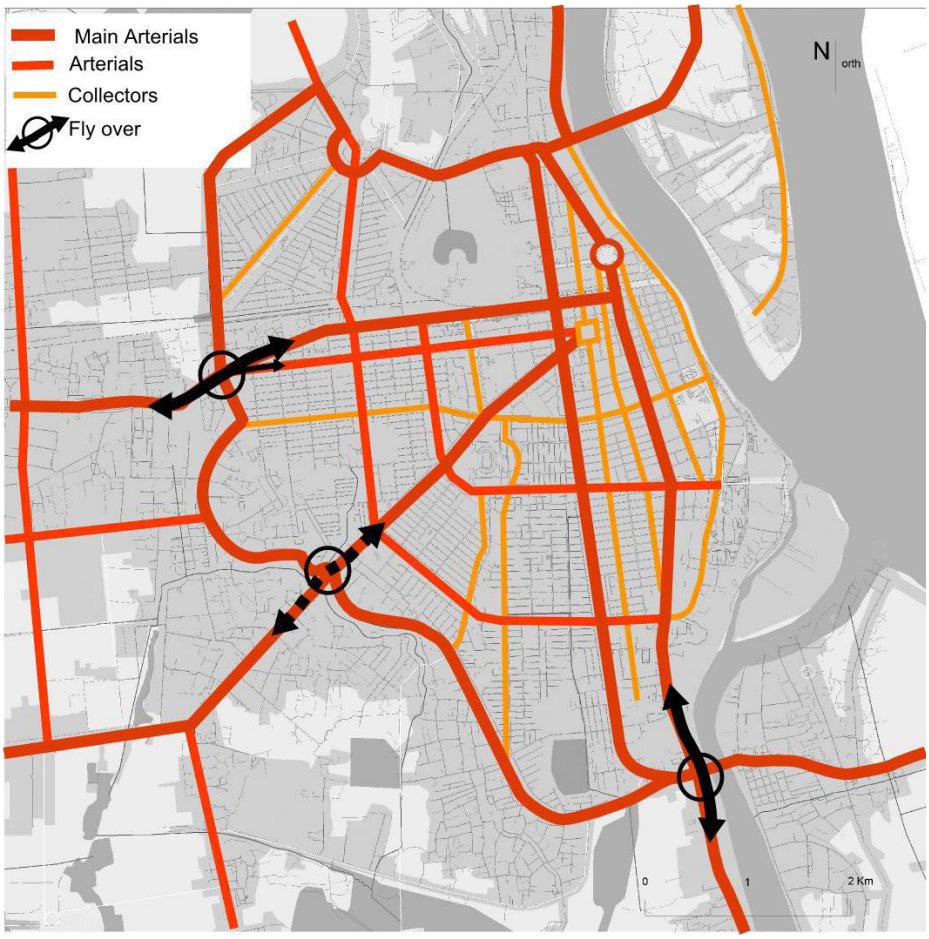


Figure 2-3: 4 central districts road network – source SYSTRA 2012

2.2.2 Road Users

All road users should share the responsibility to use the road system safely and responsibly, and with consideration of other road users. Road users such as children, pedestrians, motorcyclists, bicyclists, elderly people and people with disabilities had suffered disproportionate amount of fatality and injury in the road system due to the increased risks that they face when travelling in road system that does not protect them. For example, children must cross a busy road to get to school, pedestrians must walk along

the road because there is no facility for them, and motorcycle must share the road with cars and heavy vehicles and so on. In city, about 80 percent of total traffic is motorcycle users; therefore the traffic situation seems a bit mess and the issue of the traffic management is how to effectively ask the road users to follow the traffic rules. The human factor contributes almost 95 percent of road crashes (RCVIS, 2010). The highest number of fatalities was observed in Phnom Penh (296) followed by Kampong Cham province (184), Kandal province (135) and Battambong province (123) (see Figure 2-4).

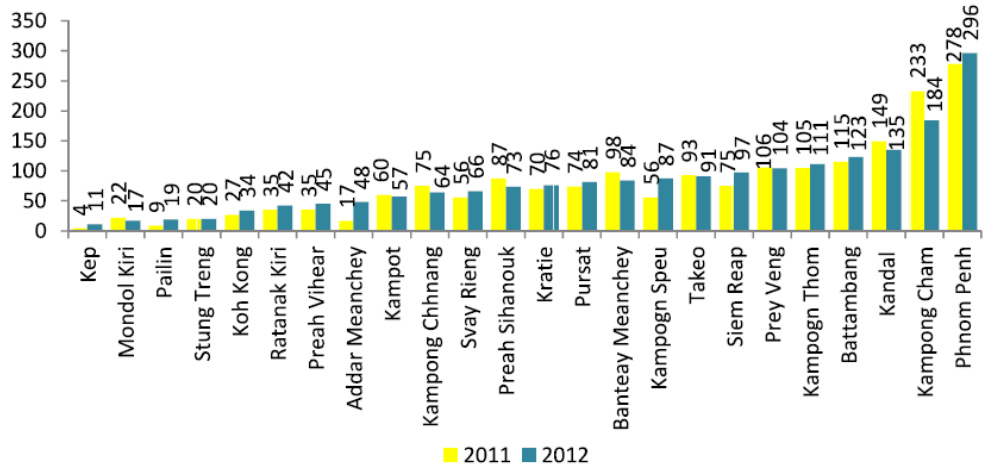


Figure 2-4: Number of fatalities in Phnom Penh and provinces – source NRSC and RCVIS 2012

The high number of fatalities is mostly due to drivers' behaviour which usually happens when they drive with risky driving behaviours such high speed driving, drunk driving, careless driving, making or receiving phone call, sleepy or fatigue driving, driving without wearing helmet or seat belt and others risky driving behaviours. According to the Department of the National Police, 287 cases of traffic accidents were caused by high speed driving and careless driving, which is about one third of all traffic accidents. Drunk driving is the second major factor that causes traffic accidents. The drivers who get drunk cannot concentrate on their driving which can lead them to get an accident easily. This kind of accident can cause the driver a very serious injury, especially when the drivers do not fasten their seat belts or wearing their helmets. The third factor is that the drivers do not obey the traffic laws and do not respect the priority right of the others. More than 90 percent of motorcycle drivers have no driving license and many of them do not obey the traffic rule (JETRO, 2008). Some drivers still continue to drive even the traffic light turn red, some stop their vehicles at the places that the laws do not allow them

to stop; the others even drive their vehicles through the wrong direction and so on. Figure 2-5 shows that over speed driving was the leading cause of crashes in both day time and night time following by drunk driving, dangerous overtaking, not respect right of way and so on. Over speeding shared proportions in day and night crashes around 50 percent. Drunk driving contributed to 21 percent of night crashes and 10 percent of day crashes.

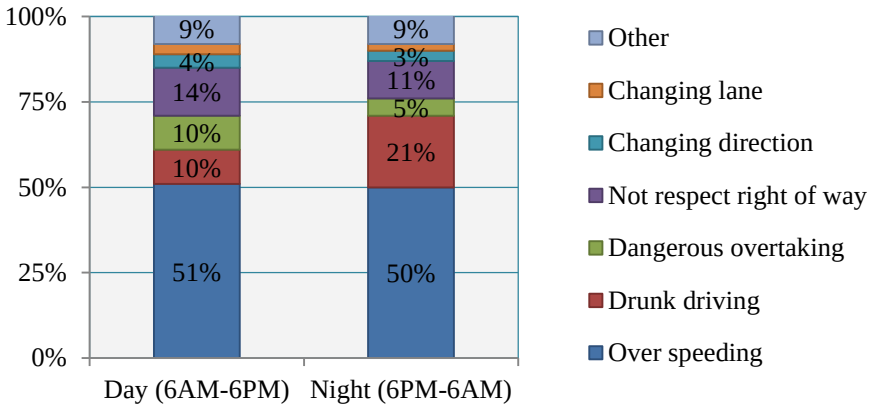


Figure 2-5: Percentage of crashes and fatalities by time – source RCVIS 2010

2.2.3 Vehicles

The number of vehicles have been increasing remarkably. The number of registered vehicles in 2010 is about 1,120,887 vehicles which includes 887,889 vehicles for motorcycle, 205,860 vehicles for light vehicles and 27,138 vehicles for heavy vehicles (See Table 2-1). Most of the vehicles especially cars operating in Phnom Penh are second-hand cars and many would not pass safety standards, or they are vehicles that were in major crashes and only the exterior of the car was fixed before being imported from other countries. Vehicles is the second factor of provoking road crashes after human factor. Most of vehicles, which are used in Phnom Penh city are motorcycles and private cars. Some invented vehicles, which are the combination of motorcycle and cart, are also found to be operated on roads in city for leisure or in order to carry light freight. They are also a contributor of traffic problems in city (accident and congestion).

Table 2-1: Registered vehicles in Phnom Penh –NIS 2010

Items		Year		
		Until 2000	Until 2005	Until 2010
Motorcycle	2-wheel vehicles	247,965	429,689	884,667
	3-wheel vehicles	0	0	3,222
	Total	247,965	429,689	887,889
Light Vehicles	Tourist car	49,598	87,887	147,167
	Mini bus	5,888	11,366	19,161
	Pick up	14,560	25,472	39,532
	Total	70,046	124,725	205,860
Heavy Vehicles	Bus	971	1,711	2,729
	Truck	12,283	17,953	23,465
	Trailers	267	365	944
	Total	13,521	20,029	27,138

Source: Department of Public Works and Transport, Phnom Penh

2.2.4 Transportation Modes in Phnom Penh

Various modes of transport are currently operated in city. Mostly, transport system is dominated by private transportation modes, which result in higher risk of accidents and less reliability. The transportation modes in Phnom Penh city is divided into two types: urban transport and interurban transport.

2.2.4.1 Urban Transport

⊙ **Individual Transport Modes**

Individual transports modes tend to increase steadily. They are the majority of mechanized transport modes and now present more than 85 percent of mechanized trips in Phnom Penh in 2011 (SYSTRA, 2012). The individual transport modes consists of motorcycle, bike and private car (see Figure 2-6).

Motorcycles: are the main transport mode in Phnom Penh. However, they are also a primary contributor of the traffic problems on the roads. The number of such vehicles has increased from about 200,000 vehicles in 1998 to about 860,000 vehicle in 2011 (SYSTRA, 2012).

Bicycles: are still operate with the mixing traffic with motorcycle. They are decreasing and represent a very small part of mechanized trips.

Private cars: have become the second transport mode. The number of private car has increased from about 50,000 vehicles in 1998 to about 235,000 vehicles in 2011.

Motorcycle

Bicycle – source SYSTRA

Private car – source SYSTRA

Figure 2-6: Individual transport modes: motorcycle, bicycle and private car

⊙ **Public Transports Modes**

Unlike other developing cities in Southeast Asia, only some transportation modes is currently operating in Phnom Penh, as shown in Figure 2-7. The only modes that can be considered public transportation such as motor taxi (Motordop), three wheel motorcycle taxi which are the door-to-door transport modes, taxi car, tricycle (Cyclo). Implementing regular public transport such as buses or urban rail transit will imply a change in mentalities and travel behaviour.

Motorcycle taxi (Motordop)

Three-wheel motor-taxi

Tricycle (Cyclo)

Taxi car

Figure 2-7: Public transport modes in Phnom Penh city

Motorcycle taxis (Motordop): are a kind of para-transit which used to be the dominant public transport mode in 2001. They are the cheapest transport modes comparing with other modes. They are also a contributor of traffic problems in city (dangerous and uncomfortable for passengers). They are the major public transport system in city which has a lot of flexibilities, but it also decrease the transport effectiveness.

Three-wheel motor taxis: have become the main public transport mode and tend to replace motor taxi. They are mainly used for leisure or in order to carry light freight.

Taxi cars: are the main transport mode in city. However, they are also a primary contributor of the traffic problems on the roads. The number of such vehicles has increased from about 200,000 vehicles in 1998 to about 860,000 vehicle in 2011 (SYSTRA, 2012).

Tricycles (Cyclos): are also a common public transport mode, which mostly operate for short-distance transport. Today, they are used for goods transport. Recently, the number of tricycles has drastically decreased due to the slow speed and the friction with other vehicles on roads.

⊙ Other Modes

Beside individual transport modes and public transport modes, there are also several available transport modes in city such as worker trucks, motor-remorks, and minibuses (see Figure 2-8).

Worker truck – source Google

Motor-Remork

Minibus

Figure 2-8: Other transport modes: worker truck, motor-remork, and minibus

Worker Trucks: are used by private companies in order to transport factory workers. This informal public transport mode presents the worst transport conditions. It is considered an unsafe transport mode.

Motor Remorks: are considered in kind of para-transit. They are an informal transportation modes which are now used mainly on the outbound of the city and used by factory workers to commute or by farmer to transport their products to markets. They used to represent about 9 percent of motorized trips in 2001 (SYSTRA, 2012) but recently, they tend to decrease.

Minibuses: are used for private transport like private schools but also sometimes for company employees.

2.2.4.2 Interurban Transport

- **Intercity buses**

Buses are mainly operated for only in inter-city there is no bus running in inner-city (see Figure 2-9). There are a lot of intercity buses owned by different companies in different locations that reach different cities in Cambodia as well as other cities in Thailand, Vietnam and Laos. Bus terminals are mostly located near the markets, where the traffic congestion often occurs because of merging of large number of buses and other vehicles (see Figure 2-10).

Figure 2-9: Intercity bus

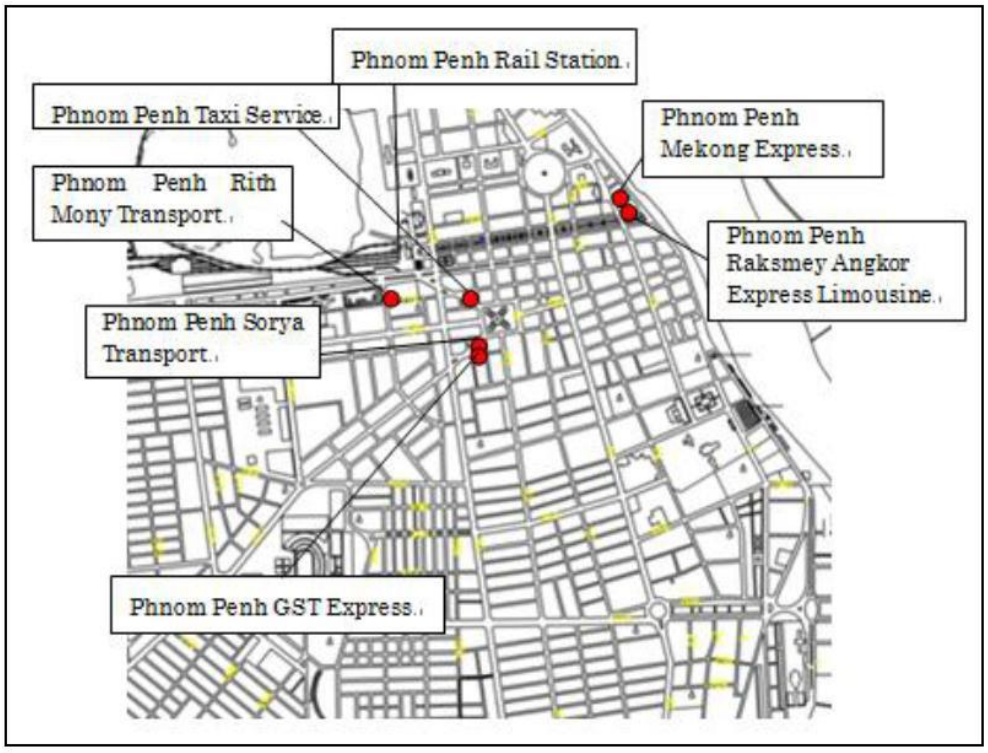


Figure 2-10: Location of bus station in centre area – source SYSTRA 2012

⊙ Railways

Railway are operated by Royal Railways of Cambodia. Railway network consist of 2 routes which are operated for the intercity service linking from Phnom Penh city to Southern part and Western part of Cambodia (See Figure 2-11). There are no rail passenger services operating for urban or interurban transport. Today, it is served to transport goods or petroleum from Sihanouk Ville port to Phnom Penh city. The railways are currently being rehabilitated by the Government of Cambodia, with funding from the Asian Development Bank, Australian Agency of International Development and Australian Company Toll Holdings.

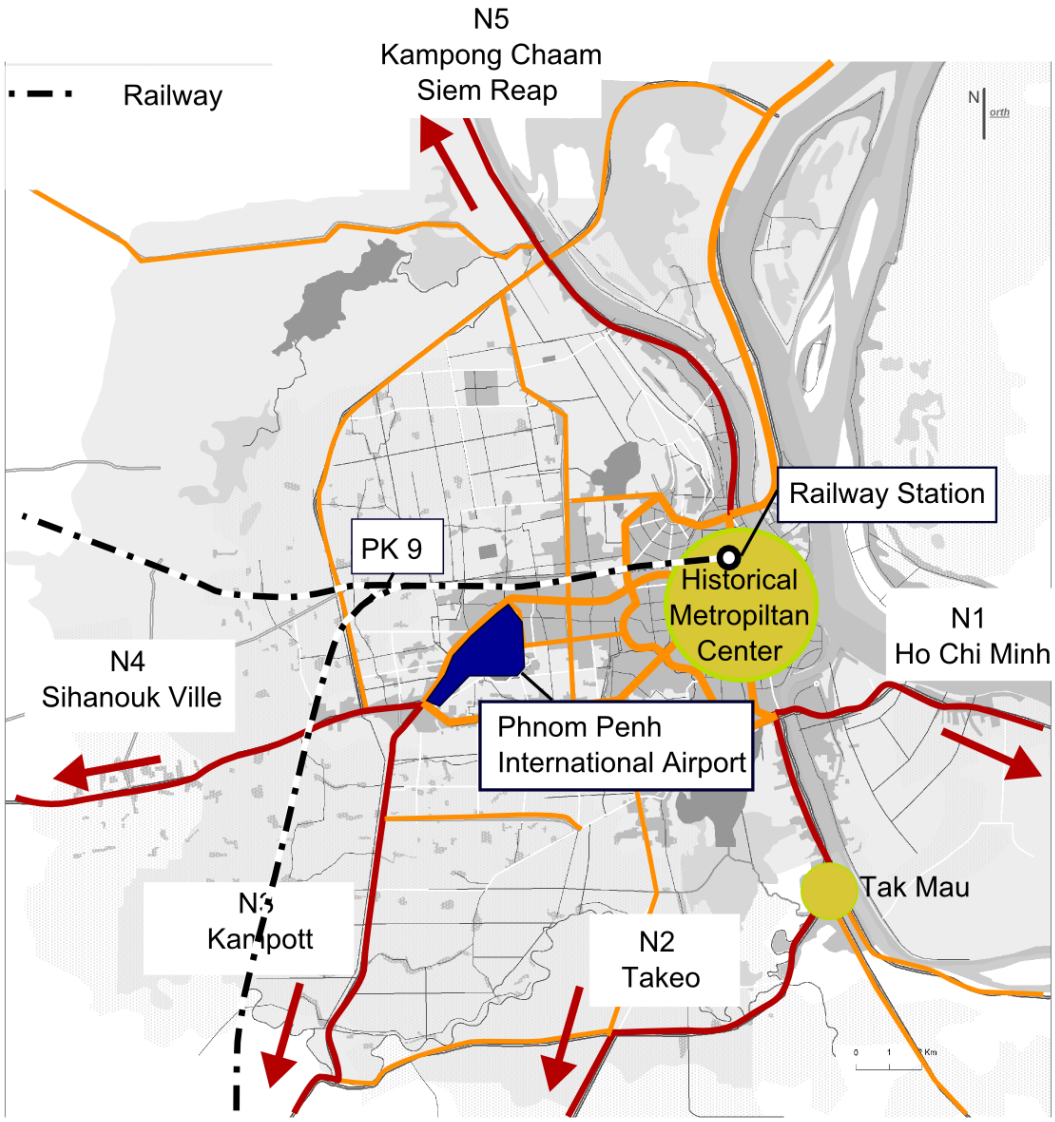


Figure 2-11: Location of railways and PP international airport – source SYSTRA 2012

⊙ Phnom Penh international airport

Phnom Penh international airport is operated on international routes and domestic routes. As showing in Figure 2-11, Phnom Penh international airport is located about 10 kilometres on the west part of Phnom Penh city and is connected to the city centre with Russian confederation Boulevard. It is the largest airport in Cambodia containing land area of 387 hectares (see Figure 2-12). In 2012, the airport had received the total passengers about 2,077,282 people and total aircraft movements of about 22,534 movements (Wikipedia, 2014). This numbers is still small comparing to other airport in Southeast Asia countries.

Figure 2-12: Phnom Penh international airport

⊙ Water Transport

Water transport is also being operated for both intra-city and inter-city service. The intra-city service is served for sightseeing in the city along Mekhong River and Bassac River whereas the inter-city service is used to transport goods and passenger from Phnom Penh city to other provinces such as Siem Reap province, Kampong Chnang province and also to Ho Chi Minh City in Vietnam.

Figure 2-13: Waterway

2.3 Future Urban Transportation Planning

The fast growing population and urban development of Phnom Penh has recently caused several traffic problems. Firstly, the numbers of vehicles circulating through the city and daily trips have been increasing due to an increase in urban population. Secondly, the capacity of road network in both urban and suburban areas, including national roads, cannot support the growing traffic demand, and the pavement status is generally in poor conditions; the traffic issues have become worse and are contributing to the social problems of metropolitan area. Municipality of Phnom Penh is working hard on traffic improvement projects.

Based on the future master plan in 2020 reported by JETRO, road transport and the development of public transport system in Phnom Penh city was planned to support the decentralized urban structure (4 inner cities) with 2.2 million population (see Figure 2-14). Based on the radial ring-road network for the future public transport system, urban rail transit and bus transport system will be introduced inside the urban area not only inner city but also sub-cores.

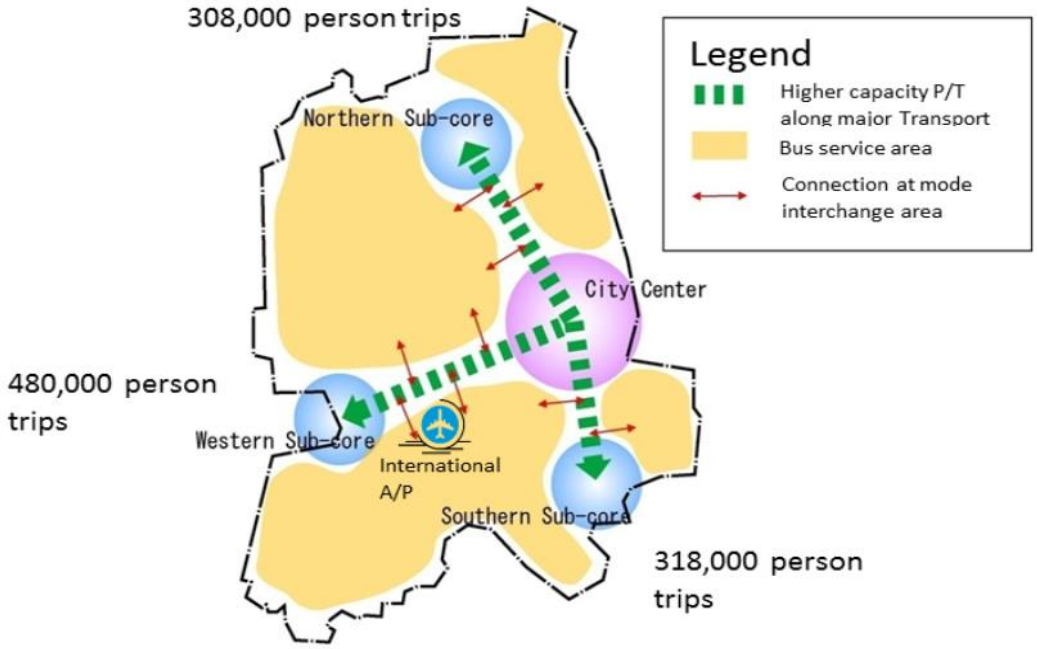


Figure 2-14: Public transport systems – source JETRO 2008

It was found that western transport corridor has high priority for introduction of public transport system (See Figure 2-14). Among 3 corridors, the western transport corridor has the largest public transport demand of 480,000 person trips in 2020 (JETRO, 2008). The current development conditions and the location of major urban vital facilities corridor development are ongoing along western transport corridor where Phnom Penh International Airport, the largest mode interchange area is located.

In order to resolve the increasingly serious traffic problems in the metropolitan area, a feasibility study on public transportation systems of Phnom Penh Sky Rail (airport line) was conducted by JETRO. It is necessary to construct a new rail system which will provide a smooth, reliable, environmentally friendly and safe transit system along the selected corridor with adequate passenger capacity.

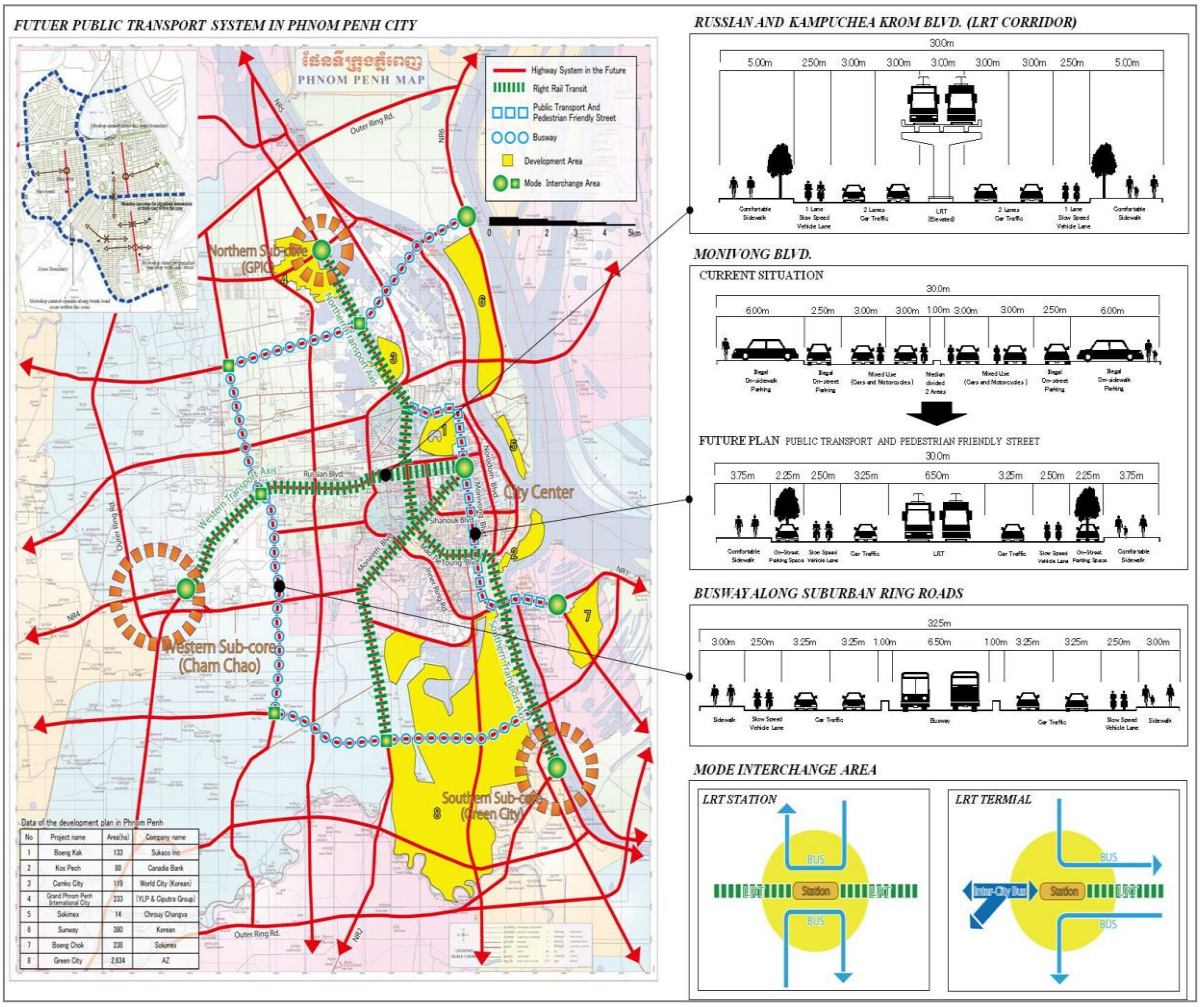


Figure 2-15: Future public transport systems in Phnom Penh – source JETRO 2008

This rail system will improve the convenience of Phnom Penh citizens, the business community and tourists from other countries. It also will prevent economic loss and discouragement of workers, shoppers and students due to chronic traffic congestion (JETRO, 2008).

From Figure 2-15, the future public transportation system in Phnom Penh City has been well planned. There will be 3 main lines of urban rail transports system and public bus system running in Phnom Penh city. The urban rail systems are designed to link traffic from the suburban-cores to downtown. And roads will be improved to have a specific lane for cars, motorcycles, and pedestrians.

2.3.1 Sky Rail Airport Line Project

The total length of the sky rail airport line is approximately 10 Km including the depot. This proposed route corridor starts from New Central Market to Phnom Penh International Airport along Kampuchea Krom and Russian Boulevard. It is an elevated viaduct structure that uses precast segmental system for the guide-way superstructure and piers which are located in the median of the main roads (see Figure 2-16).

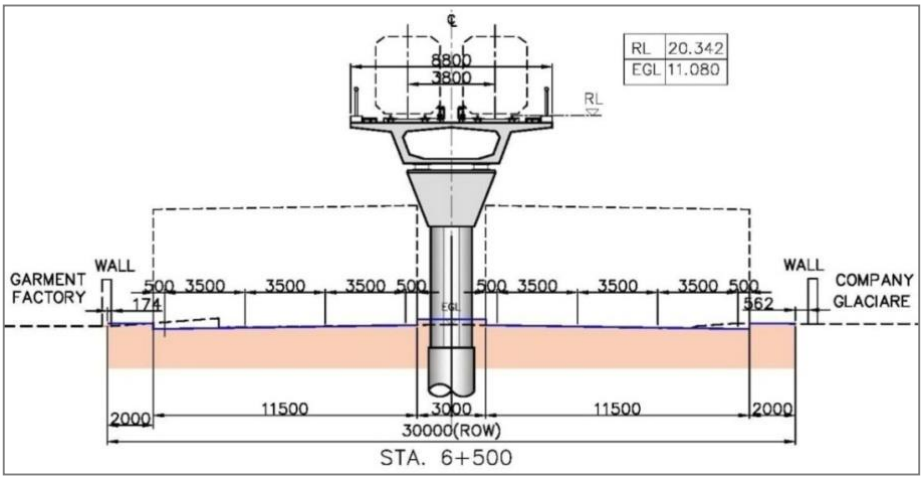


Figure 2-16: Sky rail cross section plan at Russian Boulevard – source JETRO 2008

This sky rail airport line totally has 7 stations, 3 substations and 1 depot (see Figure 2-17). Terminal stations and intermediate stations are constructed with island platforms and separate platforms given the

ease of construction work, the good visibility and the line alignment. The effective length of each platform is about 60m except for station 1, the city terminal, which should be extended to 65m to accommodate a buffer stop. There will be a concourse floor at station 7, the airport terminal, considering access to the airport building, and the future line extension plan. The other stations are going to construct without a concourse floor to reduce the construction cost (JETRO, 2008). The construction cost of this project is about US$ 309.3 million and land acquisition cost for depot and stations is approximately US$ 55.3 million (2008 year's cost).

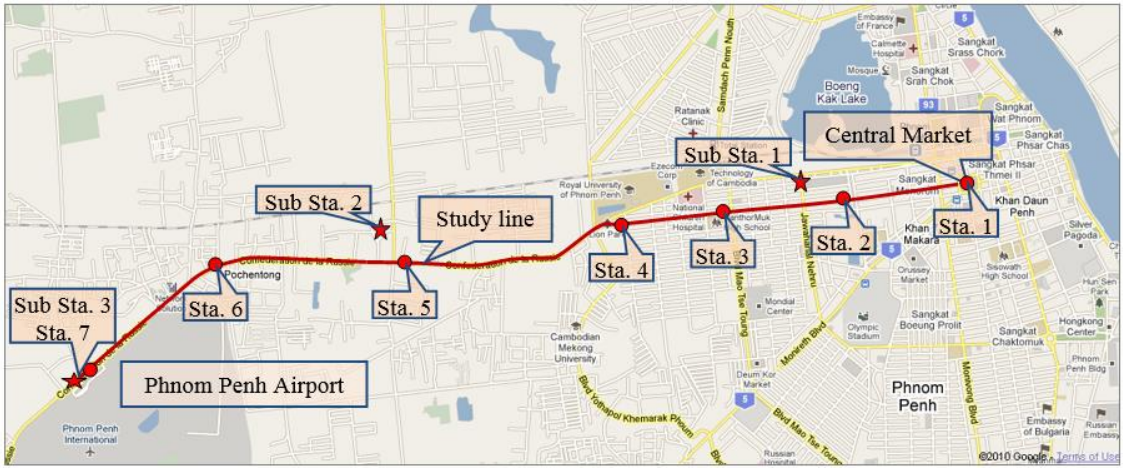


Figure 2-17: Sky rail overall plan – source JETRO 2008

2.3.2 Train Operation Plan

Table 2-2 shows the operation plan of sky rail airport line. The prediction of the number of passengers in starting year is approximately 5,500 people per hour per direction and this number is predicted to be 8,600 people per hour per direction in 2020. The train will operated 17 hours per day starting from 5 A.M to 10 P.M with the speed of 30 Km per hour. The required number of trains to operate in hour is 8 trains and in total 28 trains is needed. The normal train capacity is about 384 passengers and the maximum train capacity in peak hour is about 690 passengers. The total travel time for one round trip's train operation is about 45 minutes. The train will stop about 30 seconds for each stations and about 1 minute at the terminals.

The other surveys was also conducted in order to grasp the transportation users' attitudes for sky rail system. Regarding mode share of traffic along this study line, it was found that 73 percent of modal share was motorcycle flow by 15 percent of car, 4 percent of minibuses and vans, 3 percent of large and medium truck, 2 percent of three-wheel motorcycle. In term of fare, about 80 percent of the respondents were willing to use this new system if the fare is less than 3,000 Riels (about 0.75$) (see Figure 2-18).

Table 2-2: Sky rail airport line's operation plan – source JETRO 2008

Items	Operation
Transportation volume	5,500 p/ph/direction (8,600 p/ph/direction in 2020)
Train operation hours	17 hours (5am to 10pm)
Scheduled train speed	30 Km/h
Station dwelling time	30secs (way stations) 1min. (terminals)
Turn back time at terminals	5 min.
Train controls system	CS-ATC, ATO with driver
Normal train capacity	384 passengers
Max load factor in peak hour (approx.)	180%
Max train capacity in peak hour	690 passengers
Required number of trains operating per hour (min. headway)	8 trains (every 7.5mins)
Time required for one round trip train operation	45 minutes
Required number of trains (spare trains)	21 (3)

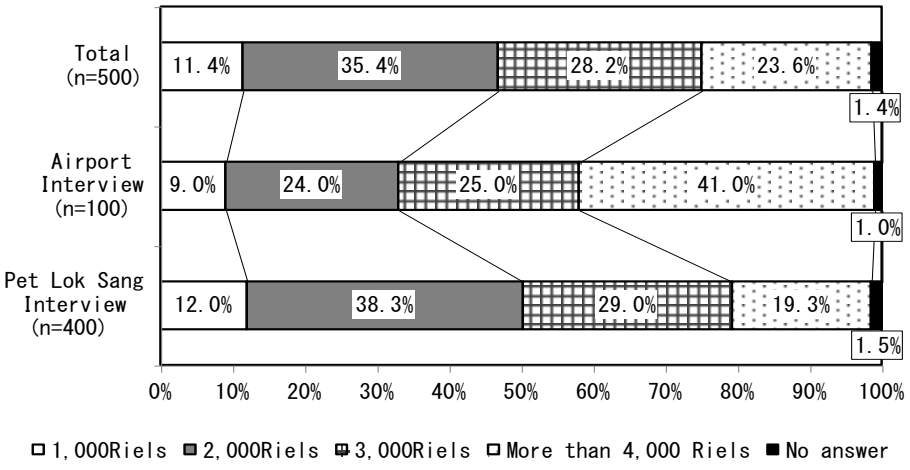


Figure 2-18: Willingness to pay for Sky rail airport line – source JETRO 2008

2.4 Review the Existing Studies of Road Users' Behaviour

The traffic conditions, problems and future urban transportation planning have been reviewed. Some solutions, cooperation, studies, experiments, countermeasures, improvement of transportation infrastructure and facilities and other safety action plans had been done and applied but still the transportation behaviour is still getting worsen currently. The traffic congestion, accidents, and violations which are the hot issue, were mostly due to the number of motorcycles, road users and their travel behaviour. The lack of public transportation in urban area is also one of the reasons. Understanding the drivers' attitudes is considered an important determinant of drivers' behaviour in driving behaviour theoretical models. Therefore, the study about drivers' behavioural intention towards new modes of urban public transport and drivers' attitudes and perception towards traffic accident are very essential.

2.4.1 Commuters' Behavioural Intention

Given aforementioned traffic issues in city, the main traffic management issues are the number of motorcycles and an insufficient urban public transportation system, which is why a new public transportation system, urban rail, has been planned in order to provide high mobility services between the urban core and suburban core, to minimize social impact and to minimize the traffic congestion by reducing the conflicting traffic. The travel demand management (TDM) or mobility management (MM) can be used to induce commuter to use more public transportation. However, the commuters along this corridor may not be familiar this new system. It is necessary to understand the psychological factors and commuter's intention of using future urban rail transport. Therefore, the investigation of psychological factors including socioeconomic variable and other variables will be revealed in this study.

Theory of Planned Behaviour (TPB), which was a well-researched model and was widely used in explaining in predicting human behaviour across a variety of disciplines (Ajzen 1991), will be used as a methodology in this research study in order to identify the factors affecting the commuters behavioural intention and behaviour. The theory has previously been successful in predicting such diverse behaviours

as choosing a career, deciding to donate blood, or deciding to use helmet, among many others. The theory has also been used in transportation research to predict behaviour. For example, in Taiwan Yang and Hsiao (2010) applied the TPB to understand travellers' intention to take high speed rail among college students. The study added two constructs, namely, novelty seeking and trust to the model of theory of planned behaviour. The sample size was collected from 300 Taiwanese students. Results indicated that attitude, subjective norm and perceived behavioural control are found to have positive effects on the behavioural intention of taking high speed rail. Novelty seeking and trust also found positively influence on attitude and three antecedents of the intention in taking high speed rail.

In Taiwan, Lam and Hsu (2006) investigated the behavioural intention of choosing a travel destination applying the theory of planned behaviour (TPB) model as a research framework. The study was an extension of TPB by adding one more variable, past behaviour, on the core constructs variable (attitude, subjective norm, and perceived behavioural control). The study sample comprised 299 potential Taiwanese travellers to Hong Kong. This study has found that subjective norm, perceived behavioural control, and past behaviour, but not attitude had direct impact on behavioural intention of choosing a travel destination among Taiwanese potential visitors to Hong Kong. Subjective norm had the greatest effect on behavioural intention of visiting Hong Kong. That is, the intention was associated with perceived social pressure from important referents of Taiwanese residents. Attitude did not play any significant role in affecting the behavioural intention of choosing Hong Kong as a travel destination when important referents and inhibiting factors existed.

Other application of the Theory of planned behaviour (TPB) was conducted by Norman and Evans (1998). The study applied the TPB to predict pedestrians' road crossing intentions. The responses were collected from 210 of road users. The respondents were ask to complete the questionnaires which included scenarios of three potentially dangerous road crossing behaviours, namely, dual carriageway, pelican crossing and residential road, followed by measures of attitude, subjective norm, perceived behavioural control, self-identity and intention. Results from the study indicated that the social psychological variables under consideration were able to explain 39 and 52 percent of the variance in

intention to across the road in the manner depicted in the scenario. The perceived behavioural control was found to be the strongest predictor of the pedestrians' road crossing intentions.

In Canada, Abrahamse (2009) investigated the factors influencing the car use for commuting and the intention to reduce it in a sample of Canadian office workers. The results showed that car use for commuting was mostly explained by variables related to individual outcomes (perceived behavioural control and attitudes) whereas the intention to reduce car use was mostly explained by variables related to morality (personal norms). The study also found that perceived behavioural control moderated the relation between personal norms and behavioural intentions: stronger personal norms were associated with stronger behavioural intentions, but only when perceived behavioural control was low.

In Thailand, Choocharukul et al. (2007) extended the theory of planned behaviour (TPB) to investigate the behavioural intention of using private car in the future work trips. The questionnaire survey was used to measure several psychological variables related to private car use for future work trips after graduation of undergraduate students. Besides, the 3 main variables of the behavioural intention: attitude, subjective norm, and perceived behavioural control, moral obligation was added as a variable to predict the behavioural intention of private car use. In the study, 156 undergraduate students who were in their senior year and were expected to graduate in the next few months were asked. Results from the structural equation models revealed that the behavioural intention of driving to work after graduation was significantly influenced by attitude, subjective norm and moral obligation. However, the perceived behavioural control did not significantly influence the behavioural intention of driving to work after graduation.

In Vietnam, Fujii and Van (2009) investigated attitudinal aspects of six travel modes currently used in Ho Chi Minh City, and examined the relationship among psychological constructs following Theory of Planned Behaviour (TPB). The sample size were collected from 208 people in public place using measures on attitudes, perceived behavioural control (PBC), subjective norm, moral obligation and intention for travel mode choices. The study applied three attitudinal factors into the TPB constructs, namely, symbolic affective, Instrumental and Social Orderliness. Results showed that all the constructs

(attitude, subjective norm, PBC, and moral obligation) explained high significant proportions of the intentions' variances. Results found that TPB was potential for predicting the behavioural intention of mode choice in HCM City.

In Sweden, Forward (2009) extended the theory of planned behaviour (TPB) to predict the intention to commit two different driving violations: speeding in an urban area and dangerous overtaking by adding descriptive norms, past behaviour, perceived ease and perceived risk in the core structure of TPB. In this study, questionnaire was mailed to 500 people drawn from the public driving license records. The questionnaires included two different driving scenarios: speeding in an urban area and dangerous overtaking. The outcome of this study found that all variables within TPB are significant relationship. Descriptive norms and past behaviour presented the strongest relationship with intention to violate. It also found that the effect of descriptive norms is greater in a situation described as risky. The effect of age and annual mileage were significant with regard to speeding indicating that young drivers and those who use the car regularly are more likely to speed. Similar study in France done by Letirand and Delhomme (2005) applied the TRA and TPB to predict and understand the speed behaviour focusing on exceeding and not on observing the speed limit. This study examines whether the evaluation of exceeding but also of observing the speed limit contributes to improving predictions of self-reported speed behaviour and determining intentions to produce each of these two behavioural options. While, Warner and Aberg (2006) applied the TPB to investigate the driver's decision to speed. The study predicted the driver's everyday speeding behaviour, using the structural equation modelling. It was found that the independent variables stipulated in the theory afforded a level of prediction of driver's self-reported speeding as well as of their logged speeding. Attitude towards speeding, subjective norm, and perceived behavioural control were significant determinants of self-reported speeding. Self-reported speeding and subjective norm contributed to the prediction of driver's logged speeding. Whereas perceived behavioural control did not directly contribute may be due to the possibility that drivers with several years of experience already take into account the actual control.

Similarly in Belgium, Paris and Broucke (2008) applied the TPB to measure cognitive determinants of speeding. The study described the development and validation of a self-report questionnaire to measure

the determinants of speeding behaviour in road traffic based on the theory of planned behaviour. The sample size were collected from 116 drivers with a provisional questionnaire measuring self-reported speeding behaviour as well as its determinants as predicted by the TPB model, namely, attitudes towards speeding and towards respecting speed limits, social norms, perceived behavioural control, and intentions. Results showed that intentions were the most strongly predicted by explicit social norms and negative attitude towards respecting speed limits. Self-reported speeding was predicted by intention and perceived internal control. In contrast, actual speeding behaviour was not significantly predicted by intentions and perceived control. The study demonstrates the validity of the theory of planned behaviour to predict self-reported speeding behaviour and provides a valid and reliable measure of the cognitive concepts featured in this model, but suggests that actual speeding behaviour can only partially be predicted from these concepts.

In China, Zhou et al. (2009) investigated the effects of age, gender and conformity tendency on Chinese pedestrians' intention to cross the road in potentially dangerous situations. A sample of 426 respondents were asked to complete a demographic questionnaire, a scale measuring their tendency towards social conformity, and a questionnaire based on the theory of planned behaviour (TPB). This questionnaire measured people's intentions to cross the road in two different road crossing situations, their attitude towards the behaviour, subjective norms, perceived behavioural control, anticipated affect, moral norms, and perceived risk. Results from the study showed that people who showed greater tendencies towards social conformity also had stronger road crossing intentions than low conformity people. Attitude, subjective norm, perceived behavioural control, and perceived risk are found to be significant predictors of behavioural intention of road-crossing. Age also emerged as a significant predictor of intentions to cross the road. It was found that older pedestrians would be less likely to intend to cross road whereas there were no gender differences in road crossing intentions.

Last but not least, another application of TPB was on intention to use bus in Ho Chi Ming city. FujiI and Van (2009) explored the behavioural intention to use the bus while considering the perceived quality of bus service, problem awareness, and moral obligation of people in Ho Chi Minh City. A mail-back survey was conducted in late August 2007 in HCMC. Questionnaires were mailed to 1,000 households

randomly chosen from the city's phone list and evenly distributed across 18 districts of the city. The purpose was to test the feasibility of developing mobility management measures persuading motorcycle users to use the bus more, and if so, how. Principal components analysis on a set of psychological factors related to various aspects of bus use yielded four factors: moral concerns, negative expression, quality perception, and social status. The regression of the intention on these four factors revealed that determinants of intention to use the bus in HCMC are moral concerns and the perception of quality. Based on the psychological relationships, mobility management measures can be applied in persuading people to change their behaviour toward using the bus. Table 2-3 shows the summary of applications of theory of planned behaviour in transportation studies.

Table 2-3: Summary of TPB applications

Authors (Published year)	**Country**	**Constructs (sample size)**	**Research on**
Yang, Hsiao (2010)	Taiwan	TPB core construct, novelty and trust (300 students)	Traveller's intention to take high speed rail
Lam and Hsu (2006)		TPB core construct, past behaviour (299 travellers)	Behavioural intention of choosing travel destination
Norman, vans (1998)	England	TPB core construct, Self-identity (210 road users)	Pedestrians' road crossing intentions
Warner and Aberg(2006)	Sweden	TPB core construct (250 drivers)	Driver's decision to speed
Forward(2009)		TPB core construct, descriptive norms, past behaviour, perceived ease, perceived risk (500 drivers)	Intention to commit two different driving violations: speeding in urban area and dangerous overtaking
Abrahamse (2009)	Canada	TPB core construct, morality (personal norm)	Factors influencing car use for commuting and intention to reduce it
Choocharukul et al. (2007)	Thailand	TPB core construct, moral obligation (156 students)	Behavioural intention of using private car in the future work trips
Fujii and Van (2009)	Vietnam	Perceived quality of bus service, problem awareness and moral obligation (1000 household)	Intention to use bus
Van and Fujii (2007)		TPB core construct, moral obligation (208 people)	Attitudinal aspects of six travel modes currently in use in Ho Chi Minh City
Letirand, et al. (2005)	France	TPB core construct	Speed behaviour
Paris, Broucke (2008)	Belgium	TPB core construct (116 drivers)	Determinants of speeding behaviour
Zhou et al. (2009)	China	TPB core construct, age, gender conformity tendency (426 people)	Chinese pedestrians' intention to cross the road

2.4.2 Drivers' Attitude towards Risky Driving Behaviour

From the review of traffic problems, there are several main factors that are associated with the cause of traffic accidents in Phnom Penh city. Similar to other cities in Southeast Asia, the human error factors are always the highest factor of causing the traffic accident compared with other factors such as vehicle and road conditions. The high speed driving, careless driving, drunk driving, distraction driving, driving without obeying the traffic laws, and drivers' awareness are the main factors causing traffic accident.

In the United States, the national transportation safety board (NTSB) reported that the drunk driving and the use of portable electronic device had led to an increased number of crashes and an increased number of fatalities. Another issue raised by NTSB was alcohol-impaired driving. Drivers who were impaired by alcohol were found at a substantially greater risk of being involved in traffic crash which frequently results in injuries or death. NTSB demonstrated that the risk of crash was found to be increase when an operator was using a portable electronic device. Distraction driving was not just about the manipulation of a device or a visual distraction. It was also about cognitive distraction or not being fully engaged in the task at hand. The attention of a driver can be diverted by other internal or external source. It was found that distraction was complicated and till now many researches on what the human brain can and cannot handle are conducting (NTSB 2012).

Changing drivers' attitude and their individual behaviour is one of the educational measures to reduce traffic accident. Some studies had been conducted on drivers' attitudes while it was believed that safer attitudes had played a dominant role in prevention of road traffic crashes. As in Iran, Mirzaei et al. (2014) conducted study on drivers' knowledge, attitude and practices. The study evaluated the relationship between driver's knowledge, attitude and practice regarding traffic regulations and their deterministic effect on road traffic crashes. The result showed that higher knowledge, safer attitude and safer practice were associated with a decreased number of road traffic crashes.

Also in Greece, Sophia and George (2013) investigated drivers' self-reported behaviour and attitudes to risky behaviours related to the traffic violations of speeding, drink-driving, and cell phone usage using

cluster analysis. The analysis was identified three clusters of drivers. Drivers in cluster 1 commit traffic violation more often, cluster 2 favour traffic violation countermeasures while having moderate views toward compliance with traffic rules and drivers in cluster 3 strongly support traffic violation countermeasures and also have strong views toward compliance with traffic rules.

In Norway, Iversen (2004) investigated whether attitudes towards traffic safety issues were predictors for future risk behaviour in traffic. The study examined the identical item tools measuring attitude and behaviour among 1640 drivers at two data collection points which enables investigation of consistency of measurements, and also a study of the relationship between the two variables. Results showed a high correlation between the dimensions of attitudes and behaviour at the two data collection points. Attitudes measured at the first survey had consistent effects on risky driving behaviour measured at the second survey. Drivers who were involved in traffic accidents or crashes in the last year took more risks when driving.

In Turkey, Simsekoglu and Lajunen (2008) conducted a study to investigate seat-belt use in reducing injury severity in road traffic accidents, a large number of car occupants did not use a seat-belt in Turkey. The study aimed to explain self-reported seat-belt use among front seat passengers with the basic and extended of theory of planned behaviour including habit, moral norm and anticipated regret added. 277 students were asked to complete questionnaire including demographic information and the TPB and the health belief model (HBM) items applied to seat belt use. Structural equation modelling (SEM) techniques were used in analysis of the data. Results showed that the basic TPB model showed a good fit to the data whereas the extended TPB model and the HBM model fitted the data poorly. Within the basic TPB model, attitudes and subjective norm had a positive relationship to seat-belt use intention for both urban and rural roads.

In China, Zhou R. et al. (2009) conducted research to examine young driving learners' intention to use a handheld or hands-free mobile phone when driving. A sample of 164 young driving learners completed a questionnaire based on the theory of planned behaviour (TPB), which measured people's intentions to use mobile phone while driving in handheld condition or hands-free condition, along with their attitudes

towards the behaviour, subjective norms, perceived behavioural control. The regression analysis models revealed that the TPB was able to explain 43 and 48 percent of variance in hands-free mobile phone use intention and handheld mobile phone use intention, respectively, with perceived behavioural control emerging as the strongest predictor.

Another study in 1998, Groeger and Rothengatter (1998) researched on traffic psychology and behaviour. The study covered the wide range of driver behaviour and the approaches within psychology. The brief overview of the relevant topics such as driver perception and cognition and the social psychology of driving were discussed. Traffic psychology was found to be significant contribution to make the development of accident countermeasures. Also, the issues relating to stress, fatigue and arousal had been current themes in psychological studies of driving and transport operation.

To deal with the psychological issues, the structural model analysis is widely used. Structural equation modelling (SEM) was a useful statistical methodology for representing, estimating, and testing a network of causal relationships between variables (measured variables and latent variables). SEM was called multivariate analysis with latent variables and also called causal modelling or covariance structure analysis. SEM was a valuable methodological tool that had gained popularity across many disciplines in the past two decades perhaps due to its generality and flexibility (Golob 2003). Essentially the broad framework that includes many well-known procedures such as multiple linear regressions, factor analysis, path analysis; structural equation modelling allows for analysis of causal patterns among unobserved variables represented by multiple measures. It permits testing of causal hypotheses and theory, examination of psychometric, enhancement of the explanatory power of correlational data, extension of theories and so on. SEM has also been used in the transportation research to investigate the drinking driving behaviour.

For example in 1978, Norstrom (1978) developed a simple causal model of drunk driving with the sample data of 1,541 Swedish drivers. The model was used three background demographic variable (age, sex, and marital status), two opportunity variable (mileage, alcohol consumption) and two subjective measures (perceived risk of an accident after drinking and moral attachment to the law) to predict the self-reported

frequency of drunk driving. In addition, knowledge of the law and perceived risk of arrest was also analysed in the model. The model found no significant direct effects of the demographic variables on drunk driving but showed that these variables acted through the intervening variables. It was found that knowledge of law was the best predictor of alcohol-impaired driving. In a later study, Norstrom replicated the previous finding with a larger Swedish sample and changing the analysis program to LISREL computer program which allowed the use of multiple indicators to measure drunk driving and moral attachment to the law as latent variables (Norstrom 1978). Similarly, Berger and Snortum (Berrer and Snortum 1983, 1986) applied SEM to predict the alcohol-impaired driving in US. The study was also replicated Norstrom's model with a sample of American drivers and extended Norstrom's model by examining the effects of several psychological variables and socio-economic variables. The study used the telephone interview base to collect data such as demographics information, behaviours, and attitudes concerning alcohol use and drinking driving violations. The study showed that the structural model of factors predicting alcohol-impaired driving in the U.S. has essential features consistent with Norstrom's models.

Other application of SEM in safety science research was done in Norway by Ullegerge and Rundmo (2003) whose study attempted to integrate the personality trait approach and the social cognition approach in order to understand the mechanisms underlying young driver's risk-taking behavior in traffic. The study was based on questionnaire survey carried out among 1932 young drivers which included measures of risk perception, attitudes toward traffic safety and self-reported risk-taking in traffic. In Taiwan, an application of SEM in the study of accident analysis and prevention was also conducted. Chen (2009) explored the relationships between personality factors, attitudes toward traffic safety and risky driving behaviour among young motorcyclists. The sample of study was collected from 257 university students. Results showed attitudes toward traffic safety are directly associated with risky driving behaviour.

Another research in Australia investigated the strength of relationship between personality factors, risk perceptions and driving behaviour among young and inexperienced drivers. The online questionnaire survey was used and about 159 samples were collected from student who aged between 17 and 20 years old. The result from the structural model showed that the structural equation model was a good fit to the

data and the total effects (both direct and indirect) of the four predictors (four risk perception variables) enabled the relative importance of the predictor variables to be compared (Machin and Sankey 2008). Table 2-4 shows the summary of researched studies of drivers' attitudes towards traffic accident.

Table 2-4: Summary of drivers' attitudes studies

Authors (Published year)	Country	Factors, methods (sample size)	Research on
Mirzaei et al. (2014)	Iran	Drivers' knowledge, attitudes and practices (KAP).	Relationship between drivers' KAP regarding traffic regulations and their deterministic effect on road crashes.
Sophia and George (2013)	Greece	Self-reported behaviour and attitudes to risky behaviour, Cluster analysis.	Drivers' self-reported behaviour and attitudes to risky behaviours related to traffic violations of speeding, drinking driving and cell phone use.
Iversen (2004)	Norway	Attitudes toward traffic safety (1640 drivers)	Investigation whether attitudes toward traffic safety issue are predictors for future risk behaviour in traffic.
Ullegerge and Rundmo (2003)		Risk perception, attitudes toward traffic safety and self-reported risk-taking, SEM (1932 drivers)	Integration the personality trait and the social cognition approach to understand the mechanisms underlying young driver's risk-taking behaviour in traffic.
Simsekoglu and Lajunen (2008)	Turkey	Seat belt, SEM (277 students)	Investigation seat belt use in reducing injury severity in road traffic accidents.
Zhou et al. (2009)	China	TPB, Intention (164 drivers)	Young driving learners' intention to use a handheld or hand-free mobile phone when driving.
Groeger and Rothengatter (1998)		Traffic psychology and behaviour	Driver perception and cognition and social psychology of driving.
Chen (2009)		Personality factors, attitudes (277 university students)	Relationships between personality factors, attitudes toward traffic safety and risky driving behaviour among young motorcyclists.
Norstrom (1978)	Sweden	Demographic variable, alcohol consumption, knowledge of law…etc (1541 drivers)	Developed a simple casual model of drunk driving
Berrer and Snortum (1983,1986)	United States	Alcohol-impaired driving, SEM	Prediction the alcohol-impaired driving by extended Norstrom's model.
Machin and Sankey (2008)	Australia	Personality factors risk of perceptions, SEM (159students)	Relationship between personality factors, risk perceptions and driving behaviour among young and inexperienced drivers

2.4.3 Summary

From the literature reviews, it was observed that most of TPB applications were applied on car, motorcycle, bus, high speed rail, pedestrians, and other road users by focusing on drivers' intention to choose speed, driving violation, traffic regulation, choosing travel mode and travel destination, road crossing and so forth. It can be seen that there was a limit on studies that have been conducted between

psychological factors and the behavioural intention of future urban rail transport. As Phnom Penh commuter, no implication was found. Thus, there is still a research gap to further explore the potential of psychological methods to predict commuter's behavioural intention. In addition, the core construct of TPB may not enough to predict the users' behaviour intention toward future urban rail usage, therefore the advance modification of TPB to predict the users' behaviour intention is necessary. Some latent psychological factors which can explain more about the behaviour intention towards future urban rail transport will be added to the TPB constructs.

It is also seen that several attitudes and psychological factors had influence on drivers' perception and behaviour towards traffic accident under the risky driving behaviours. In regard to the drivers' attitude and traffic psychology study, the study of the potential relationship between drivers' perception and their attitudes and other psychological factors towards traffic accident is quite limited. Especially, the study of the relationship between drivers' self-reported perception of riskiness of traffic accident and drivers' attitude to drunk driving, distraction driving, careless driving, awareness of safety, awareness of law and other psychological factors was not found. Also the application of structural equation modelling in the related issue is still limited. It is not known whether the structural model of perceived risk of traffic accident and which psychological factors will be statistically significant to describe the drivers' behaviour. Thus, a research gap still exists to further explore the potential of the psychological factors to predict the driver's attitudes toward the perceived risk of accident. Moreover, in case of Phnom Penh the study to investigate the relationship between driver's attitudes, self-reported behaviour and risk of traffic accident has not yet been found. Therefore, understandings driver's attitudes and their behaviour are very important and useful to reduce the road traffic accident.

Chapter 3

Research Methodology

This chapter describes the methodologies, theory of planned behaviour (TPB), fundamentals of structural equation modelling (SEM) and other relevant issues in the context of this research. Section 3.1 reviews the theory of planned behaviour (TBP), TPB questionnaire design and TPB sample size. Section 3.2 describes the structural equation modelling, Software package and program use, sample size requirement, and some numerical problems in structural equation modelling.

3.1 Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB) was proposed by Icek Ajzen in 1985 through his article "From intentions to actions: A theory of planned behaviour". The theory was an extension of the Theory of Reasoned Action (TRA) (Ajzen and Fishbein 1975, 1980). The theory was grounded in various theories of attitude such as learning theories, expectancy-value theories, consistency theories and attribution theory. TPB was a well-researched model which was widely used in explaining in predicting human behaviour across a variety of disciplines (Ajzen 1991). TPB will be used as a methodology in this research study in order to investigate the factors affecting the commuters' intention and behaviour.

Theory of Reasoned Action (TRA) suggested that a person's behaviour was determined by intention to perform the behaviour and that intention was a function of attitude toward the behaviour and subjective norm (Ajzen 1985). However, an additional construct of perceived behavioural control (PBC) which was an antecedent variable affecting both intention and behaviour had been added to the TRA model. TRA could adequately predict behaviours under volitional control but under circumstances where there

were constraints on action, the mere formation of an intention is insufficient to predict behaviour (Yang and Hsiao, 2010).

The best predictor of behaviour was intention. Intention was the cognitive representation of a person's readiness to perform a given behaviour, and it was considered to be the immediate antecedent of behaviour. This intention was determined by three things: their attitude toward the specific behaviour, their subjective norms and their perceived behavioural control.

According to the theory of planned behaviour, people's attitude towards the behaviour, their subjective norm, and their perceived behavioural control can determine their behaviour indirectly via their intentions (see Figure 3-1).

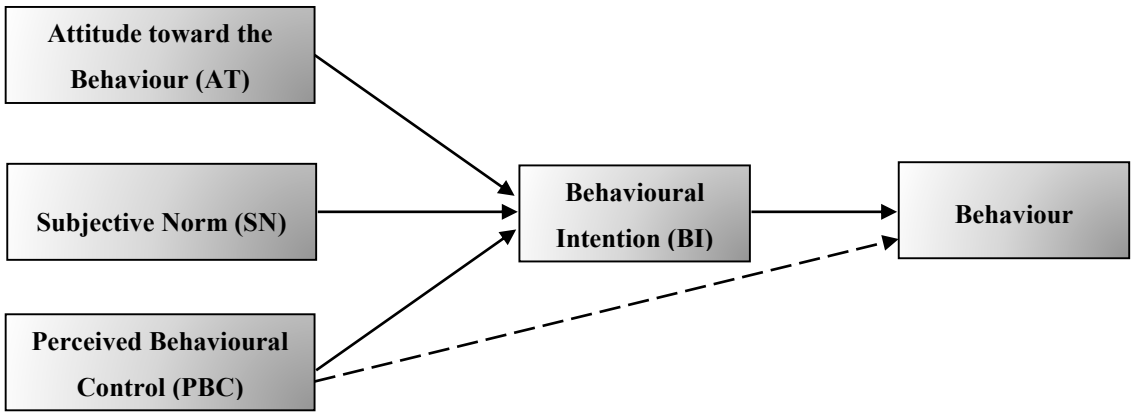


Figure 3-1: Theory of planned behaviour (TPB)

People's attitude towards a behaviour was determined by their beliefs about the likely consequences of the behaviour, their subjective norm was determined by their beliefs about the normative expectations of important people and their perceived behaviour control was determined by their beliefs about the presence of factors that may facilitate or obstruct the performance of the behaviour. The intention was defined as a willingness to try to perform the behaviour and the behaviour refers to a defined action. The more positive a person's attitude and subjective norm was, and greater their perceived control, the stronger were their intention to perform the behaviour (Ajzen, 1991). As a general rule, the more favourable the attitude, the subjective norm and the greater the perceived control, the stronger the

person's intention to perform the behaviour. TPB is regarded as one of the psychological theories that have been applied in the travel behaviour research in predicting travel behaviour.

Attitude toward the behaviour (AT) is defined as the individual's positive or negative feelings about performing a behaviour. It is determined through an assessment of one's beliefs regarding the consequences arising from a behaviour and an evaluation of the desirability of these consequences (Eagly et al. 1993). Jillian et al. (2004) defined that attitude is a person's overall evaluation of the behaviour. It is assumed to have two components which work together: beliefs about consequences of the behaviour (behavioural beliefs) and the corresponding positive or negative judgments about each these features of the behaviour (outcome evaluations). AT is a function of the product of one's important belief (B) that performing the behaviour will lead to certain outcomes, and an evaluation of the outcomes (E) (Chang 1998). Attitude thus is defined as: $\boldsymbol{AT} = \sum \boldsymbol{B_i E_i}$

Subjective norm (SN) is defined as an individual's perception of whether people important to the individual think the behaviour should be performed (Eagly et al. 1993). Jillian et al. (2004) defined that subjective norms are a person's own estimate of the social pressure to perform or not perform the target behaviour. SN are assumed to have two components which work in interaction: beliefs about how other people, who may be in some way important to the person, would like them to behave (normative beliefs or descriptive) and the positive or negative judgments about each belief (injunctive). SN is a function of the product of one's normative belief (NB) which is the "person's belief that the important referent thinks he should (or should not) perform the behaviour" (Ajzen and Fishbei, 1980), and his or her motivation to comply (MC) to that reference (Chang 1998). Thus Subjective Norm can be defined as: $\boldsymbol{SN} = \sum \boldsymbol{NB_i MC_i}$

Perceived behavioural control (PBC) is defined as one's perception of the difficulty of performing a behaviour. PBC views the control that people have over their behaviour as lying on a continuum from behaviours that are easily performed to those requiring considerable effort, resources, etc. (Eagly et al. 1993). Jillian et al. (2004) defined that perceived behavioural control is the extent to which a person feels able to enact the behaviour. It has two aspects: how much a person has control over the behaviour

(controllability); and how confident a person feels about being able to perform or not perform the behaviour (capability). Perceived behavioural control is a function of control beliefs (CB) and perceived facilitation (PF). Control belief is the perception of the presence or absence of requisite resources and opportunities needed to carry out the behaviour. Perceived facilitation is one's assessment of the importance of those resources to the achievement of outcomes (Ajzen and Madden 1986). PBC can be defined as $\boldsymbol{PBC = \sum CB_i PF_i}$

3.1.1 TPB Questionnaire Design

Jillian et al. (2004) provided nine phases in the construction of the theory of planned behaviour's questionnaire to measure the variables in the TPB model, some of which involve short but important tasks, with others involving a long process of empirical investigation. These steps are:

1. Define the population of interest (medical practitioners, general dental practitioners). Decide how best to select a representative sample from this population.
2. Carefully define the behaviour under study (explained using the TACT: Target, Action, Context and Time principle). Use this definition to construct a general introductory statement for the start of the questionnaire.
3. Decide how best to measure intentions.
4. Determine the most frequently perceived advantages and disadvantages of performing the behaviour.
5. Determine the most important people or groups of people who would approve or disapprove of the behaviour.
6. Determine the perceived barriers or facilitating factors which could make it easier or more difficult to adopt the behaviour.
7. For a standard TPB-based study, include items to measure all of these constructs in the first draft of the questionnaire.
8. Pilot test the draft and reword items if necessary.

9. Assess the test-retest reliability of the indirect measures by administering the questionnaire twice to the same group of people, with an interval of at least two weeks.

3.1.1.1 Measuring Behavioural Intention

Behavioural intentions were measured by three methods. Firstly, method 1 is called "Intention Performance", because in some situations, it would be possible to observe actual performance using the same measurement scale, and this direct comparability could be useful for some studies. Secondly, method 2, namely "Generalized Intention", is most commonly used in individual's own health-related behaviour (e.g. smoking, exercise). When investigating the behaviour of health care professionals, method 3 "Intention Simulation", could be a more valid proxy measure for actual behaviour, because it more closely approximates real situations that require complex clinical decisions. However, it is time consuming and should be prepared with great care, or it may be misleading. In general, the methods used to measure intentions should be guided by researchers' judgments about which types of questions seem to make sense for the behaviour and sample under investigation (Jillian et al. 2004). Generalized intention is used in the present study to understand the behavioural intention commuter's own individual intention.

3.1.1.2 Measuring Attitude towards Behaviour

Attitudes could be measured by two methods, namely, direct measurement and indirect measurement. Direct measurement involves the use of bipolar adjectives (i.e. pairs of opposites) which are evaluative (e.g. good-bad). Ideally, it is used about four items following a single 'stem' which defines the behaviour under investigation. It includes instrumental items whether the behaviour achieves something (e.g. useful-worthless) and experiential items how it feels to perform the behaviour (e.g. pleasant-unpleasant). It also includes the good-bad scale if it is appropriate to the topic, as it captures overall evaluation (Jillian et al. 2004). Indirect measurement measures behavioural beliefs and outcome evaluations. The stages of development of indirect measurement of attitudes are: (1) conduct an elicitation study to elicit commonly held beliefs; it means to identify the content of behavioural beliefs that are shared by the target

population, (2) construct questionnaire items to assess the strength of behavioural beliefs and (3) construct questionnaire items to assess outcome evaluations (Jillian et al. 2004). Both measurements of attitudes are used in the present study.

3.1.1.3 Measuring Subjective Norm

Similarly, Subjective norm was measured by two measurements: direct measurement and indirect measurement. The direct measurement of subjective norm involves the use of questions referring to the opinions of important people in general. It is used to arrange the items so that the ends of the scales are a mix of positive and negative endpoints. However, where an item is a complete sentence, and the responses range from "strongly agree" to "strongly disagree" endpoints should not be mixed (Jillian et al. 2004). Indirect measurement measures normative beliefs and motivation to comply. Following is the stage of development of indirection measurement of subjective norm: (1) identify groups, organizations and categories of individuals (reference groups) who are likely to apply social pressure with respect to the behaviour, (2) construct questionnaire items to assess strength of normative beliefs with respect to each reference group and (3) construct questionnaire items to assess motivation to comply: add items in standard format for assessing motivation to comply with pressure from each reference group (Jillian et al. 2004). The present study uses the direct measurement to conduct the TPB questionnaire for the subjective norm.

3.1.1.4 Measuring Perceived Behavioural Control

The perceived behavioural control was also measured by two measurements: direct and indirect measurement. For direct measurement, items should reflect people's confidence that they are capable of performing the target behaviour. This can be achieved assessing the person's self-efficacy and their beliefs about the controllability of the behaviour. Self-efficacy is assessed by asking people to report how difficult it is to perform the behaviour and how confident they are that they could do it. Whereas, controllability is assessed by asking people to report whether performing the behaviour is up to them and whether factors beyond their control determine their behaviour (Jillian et al. 2004). Similarly, for

indirection measurements firstly, identify the content of control beliefs which are shared by the target population about the behaviour. Secondly, construct questionnaire items to assess the strength of these control beliefs and lastly construct questionnaire items to assess the power of these control factors to influence the behaviour (Jillian et al. 2004). Direct measurement of perceived behavioural control is used in this study.

3.1.2 Sample Size

Required sample size is determined by statistical power analysis. This requires the specification of the study design and the expected effect size. Generally, a sample size of 80 would be acceptable. Note that response rates are often around 50 percent, so you need to send out 160 questionnaires to achieve this sample size unless you have reasons for thinking that the response rate will be better than 50 percent (Jillian et al. 2004).

3.2 Structural Equation Modelling (SEM)

Structural equation modelling (SEM) is a very general, very powerful multivariate analysis technique, having its roots in the 1970s. Most applications have been used in psychology, sociology, the biological sciences, educational research, political science, and market research. It has been used in modelling travel behaviour and values since 1980 (Golob 2003). SEM has become popular for several reasons such as (1) all SEM models can be represented visually, (2) a standard notation helps researchers to communicate and (3) several software packages for estimating SEM model are readily available. SEM is a modelling technique that can handle a large number of endogenous and exogenous variables, as well as latent (unobserved) variables specified as linear combinations (weighted averages) of the observed variables. Regression, simultaneous equations (with and without error-term correlations), path analysis, and variations of factor analysis and canonical correlation analysis are all special cases of SEM. It is a confirmatory, rather than exploratory method, because the modeller is required to construct a model in terms of a system of unidirectional effects of one variable on another. Each direct effect corresponds to

an arrow in a path (flow) diagram. In SEM one can also separate errors in measurement from errors in equations, and one can correlate error terms within all types of errors (Golob 2003).

The general SEM system is estimated using covariance structure analysis, whereby model parameters are determined such that the variances and covariance of the variables implied by model system are as close as possible to the observed variances and covariance of the sample. In other words, the estimated parameters are those that make the variance–covariance matrix predicted by the model as similar as possible to the observed variance–covariance matrix, while respecting the constraints of the model. An SEM structural model is used to capture the causal influences (regression effects) of the exogenous (independents) variables on the endogenous (dependents) variables and the causal influences of endogenous variables upon one another. The structural model also allows specification of error-term covariance. Goodness-of-fit tests are used to determine if a model specified by the researcher is consistent with the pattern of variance–covariance in the data.

An SEM has two primary components: the measurement model and the structural model. The measurement model describes the relationships between observed variables and the construct or latent variables are hypothesized to measure. In contrast, the structural model describes interrelationships among constructs. When the measurement model and the structural model are considered together, the model may be called the composite or full structural model (Schreiber 2008). Figure3-2 shows a basic example of component in structural equation modelling.

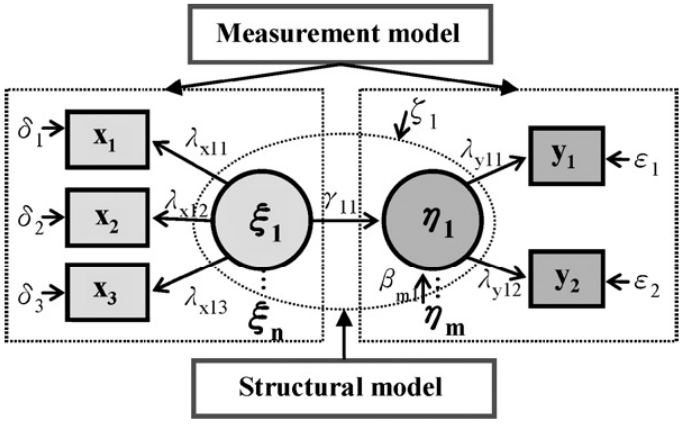


Figure 3-2: A basic example of SEM component - source Lee et al. 2008

3.2.1 Fundamental of Structural Equation Model with Latent Variable

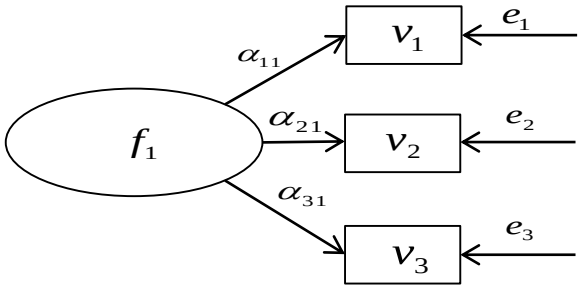


Figure 3-3: SEM model with latent variable

Observation equation: $V = A\mathrm{f} + \mathrm{e}$

Where, V- Observed variable, A- Factor loading matrix, f- Latent variable, and e- Residual vector

$$\mathbf{v} = \begin{pmatrix} v_1 \\ v_2 \\ \\ \\ v_{n_x} \end{pmatrix} \qquad \mathbf{f} = \begin{pmatrix} f_1 \\ f_2 \\ \\ f_{n_f} \end{pmatrix} \qquad \mathbf{A} = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \ldots & \ldots & \alpha_{1n_f} \\ \alpha_{21} & \alpha_{22} & \ldots & \ldots & \alpha_{2n_f} \\ \alpha_{31} & \ldots & \ldots. & \ldots & \ldots \\ \ldots. & & & \ldots & \ldots \\ \alpha_{n_x1} & \alpha_{n_x2} & \ldots & \ldots & \alpha_{n_xn_f} \end{bmatrix} \qquad \mathbf{e} = \begin{pmatrix} e_1 \\ e_2 \\ \\ \\ e_{n_x} \end{pmatrix}$$

Covariance structure:

$$\begin{aligned} \boldsymbol{\Sigma} &= E[\mathbf{v}\mathbf{v}'] \\ &= E[(\mathbf{A}\mathbf{f} + \mathbf{e})(\mathbf{A}\mathbf{f} + \mathbf{e})'] \\ &= \mathbf{A}E[\mathbf{f}\mathbf{f}']\mathbf{A}' + \mathbf{A}E[\mathbf{f}\mathbf{e}'] + E[\mathbf{e}\mathbf{f}']\mathbf{A}' + E[\mathbf{e}\mathbf{e}'] \\ &= \mathbf{A}E[\mathbf{f}\mathbf{f}']\mathbf{A}' + E[\mathbf{e}\mathbf{e}'] \end{aligned} \qquad \text{Where } \begin{matrix} E[\mathbf{f}] = 0 \, and \, E[\mathbf{e}] = \mathbf{0} \\ E[\mathbf{f}\mathbf{e}'] = E[\mathbf{e}\mathbf{f}'] = \mathbf{0} \end{matrix}$$

Estimation Parameter:

(1) Maximum likelihood (ML)

$$f(\boldsymbol{\theta}) = (n_x - 1)\left[tr(\boldsymbol{\Sigma}(\boldsymbol{\theta})^{-1}\mathbf{S}) + \ln|\boldsymbol{\Sigma}(\boldsymbol{\theta})^{-1}\mathbf{S}| - n_x\right]$$

(2) Generalized least mean square (GLM)

$$\begin{aligned} f(\boldsymbol{\theta}) &= \frac{(n_x - 1)}{2} tr\left[\left\{\mathbf{S}^{-1}(\mathbf{S} - \boldsymbol{\Sigma}(\boldsymbol{\theta}))\right\}\left\{\mathbf{S}^{-1}(\mathbf{S} - \boldsymbol{\Sigma}(\boldsymbol{\theta}))\right\}'\right] \\ &= \frac{(n_x - 1)}{2} tr\left[\left\{(\mathbf{I} - \mathbf{S}^{-1}\boldsymbol{\Sigma}(\boldsymbol{\theta}))\right\}\left\{(\mathbf{I} - \mathbf{S}^{-1}\boldsymbol{\Sigma}(\boldsymbol{\theta}))\right\}'\right] \end{aligned}$$

Where, S- the sample covariance matrix for the observed data, n_x- number observed variable, I- unit matrix, $\boldsymbol{\Sigma(\theta)}$ - population covariance matrix implied by the model with parameters $\boldsymbol{\theta}$.

3.2.2 SEM Program Use

Most SEM analyses were conducted using one of the specialized SEM software packages, such as EQS, LISREL, and Amos and so on. However, there are many options and the choice is not always easy. As an example, Amos was one of the commonly used programs for SEM analysis. Byrne (2001) conducted a study about the comparison of 3 SEM computer programs AMOS, EQS and LISREL. The comparisons focused on key aspects of the programs that bear on the specification and testing of CFA models, preliminary analysis of data, and model specification, estimation, assessment, and misspecification. In Germany, Nachtigall et al. (2003) summarized the efficiency and useful aid of using three SEM programs LISREL, AMOS and EQS. The study proposed the use of LISREL if users have different skill levels and are not sure about the right program. AMOS or EQS are used for an easy way among other SEM program with the risk of understanding the methodological complexity. Lei and Wu (2007) recommended that researchers should consult with software package publishers for more detailed information and current developments before analysing the model.

SEM software packages are generally available. Kline (1998) and Golob (2003) provided three of the most popular SEM programs:

1. AMOS (Arbukle, 1994, 2006) is a general-purpose SEM package and also available as a component of SPSS statistical analysis software.
2. EQS (Bentler, 1989, 1995) is a well-known SEM package focusing on estimation with non-normal data.
3. LISREL (Joreskog and Sorbom, 1993), with coupled modules PRELIS and SIMPLIS, is one of the oldest SEM software packages. It has been frequently upgraded to include alternative estimation methods and goodness-of-fit tests, as well as graphical interfaces.

3.2.3 Assessing Goodness-of-fit and Finding the Best Model

Many criteria have been developed for assessing overall goodness-of-fit of an SEM and measuring how well one model does versus another model. Most of these evaluation criteria are based on the chi-square statistic given by the product of the optimized fitting function and the sample size (Golob 2003). One rule of thumb for good fit is that the chi-square should be less than two times its degrees of freedom (Golob 2003). There are problems associated with the use of fitting-function chi-square. For large samples, critical number gives the sample size for which the chi-square value would correspond to p = 0.05; a rule of thumb is that critical number should be greater than 200 for an acceptable model (Tanaka 1987). For small sample sizes, asymptotic assumptions become weak, and the chi-square value derived from the ML fitting function is particularly sensitive to violations from multi-normality. Goodness-of-fit measures for a single model based on chi-square values include root mean square error of approximation (RMSEA) which measures the discrepancy per degree of freedom. It is generally accepted that the value of RMSEA for a good model should be less than 0.05 (Browne and Cudeck 1992). MacCallum et al. (1996) recommends that the entire 90% confidence interval for RMSEA should be less than 0.05. But Byrne (2009) accepted that RMSEA, the obtained value less than 0.05 indicate good fit; those ranging from 0.08 to 0.10 indicate mediocre fit and those greater than 0.10 indicate poor fit. For several goodness-of-fit indices, baseline comparison such as normed fit index (NFI), comparative fit index (CFI), a rule of thumb for most of the indices is that a good model should exhibit a value greater than 0.90 (Bentler 1990, McDonald and Marsh 1990). But Byrne (2009) accepted that the recommended acceptance of a good fit to a model requires the obtained NFI, CFI value should be in range from zero to one.

Based on these goodness-of-fit tests for a model, the modeller can take one of three different courses of action:

1. Confirm or reject the model being tested based on the results. If a model is accepted, it should be recognized that other unexamined models might fit the data as well or better. Confirmation only means that a model is not rejected.

2. Two or more competing models can be tested against each other to determine which has the best fit. The candidate models would presumably be based on different theories or behavioural assumptions.

3. The modeller can also develop alternative models based on changes suggested by test results and diagnostics, such as first-order derivatives of the fitting function (Golob 2003).

3.2.4 Sample Size Requirement

Sample size issues have received considerable attention. Maximum Likelihood (ML) estimation required a sufficient sample size, particularly when non-normal data are involved. Based on Monte Carlo studies of the performance of various estimation methods, several heuristics for have been proposed: (1) a minimum sample size of 200 is needed to reduce biases to an acceptable level for any type of SEM estimation. (2) Sample size for ML estimation should be at least 15 times the number of observed variables. (3) Sample size for ML estimation should be at least five times the number of free parameters in the model, including error terms and (4) with strongly kurtotic data, the minimum sample size should be 10 times the number of free parameters (Golob 2003).

3.2.5 Numerical Analysis Problem in SEM

Several curious phenomena have been found in the calculation process of SEM: the residual variance which is a subject on the numerical analysis in the covariance structure analysis could become a negative value or the estimated weight of a path coefficient was heavily fluctuated by constraints and if the positive/negative of an initial value is changed, the mark of the estimated weight of a path coefficient would be reversed. The diversity of solutions results or no solution results are also found with the different software packages. Similarly, Toyoda (1998) and Kojima (2003) pointed out that the value residual variance was negative and the estimated the path coefficient was changed by giving the constraints. Meguro et al. (2012) indicated although the optimized calculation was converged but the solution was still not valid since the estimated coefficient was unacceptable. Toyoda (1998, 2003) also found another problem in numerical analysis that was about initial value. It is known that there are

convergence and un-convergence and estimated coefficient changed by an initial value. Although the setting method of the initial value was proposed, initial value problem still could not be solved. It can be seen that the problems on numerical analysis such as the constraints on residual variance, initial value, software program use, diversity and instability of solution, goodness-of-fit of model are not yet be solved. Therefore, it is very important to examine and discuss in more detail on these issues.

Chapter 4

Research Framework

In this chapter, the advanced modification of TPB models and other models will be described. There are three sections of the whole research frameworks: the advanced modification of TPB model, the numerical stability in structural equation modelling and the proposed numerical procedure in SEM. Section 4.1 describes three SEM models and the framework to investigate the behavioural intention towards future urban rail transit and the perceived risk of accident of risky driving behaviour. Section 4.2 presents the numerical stability in structural equation modelling and section 5.3 shows the proposed numerical procedure in structural equation modelling.

4.1 Advanced Modification of TPB

4.1.1 Modelling Structures for Future Urban Rail

This study identify the latent psychological factor of commuters' behavioural intention toward future urban rail usage by using three sets of structural equation models. First, we develop the basic model containing only TPB variables (see Figure 4-1). Under this model structure, we hypothesize that the TPB variables, i.e. attitude, subjective norm, and perceived behavioural control, can be applied to predict the behavioural intention towards future urban rail usage.

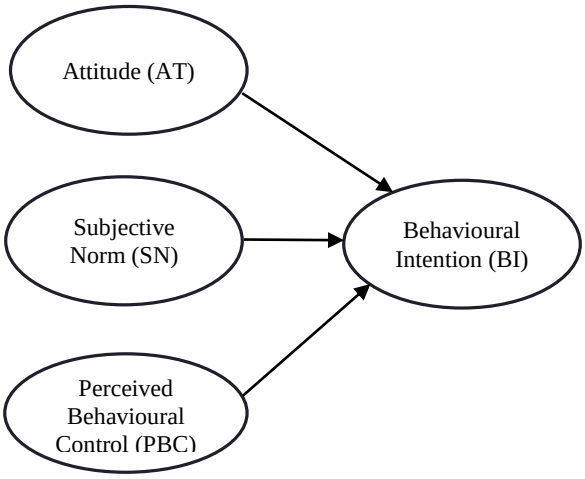


Figure 4-1: Structural model I (Basic model of TPB)

To improve the fit of the model, we propose the second model with addition of psychological variables, namely, moral obligation and awareness of consequences. At the same time, we introduce additional latent variables reflecting beliefs on attitudinal-aspects of future sky train, i.e. attitudinal beliefs on symbolic, instrumental, and social orderliness aspects (see Figure 4-2).

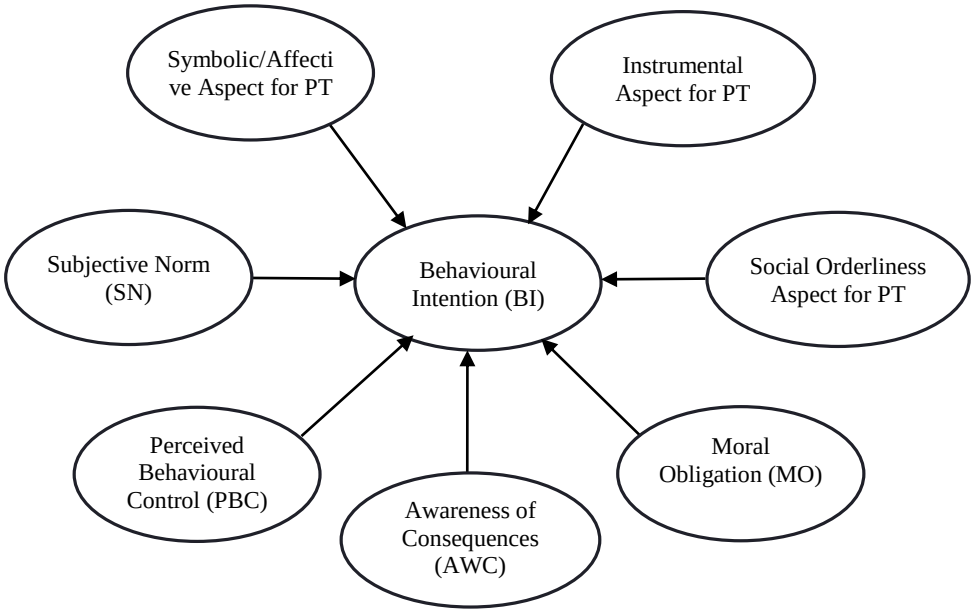


Figure 4-2: Structural model II (Enhanced TPB model)

Figure 4-3 shows the third SEM model. In the model, we test whether socioeconomic and current travel characteristics of respondents would have any effects on the behavioural intention towards future sky

train usage. Specifically, we test various variables, including, gender, occupation, income, vehicle ownership, and availability of driving license.

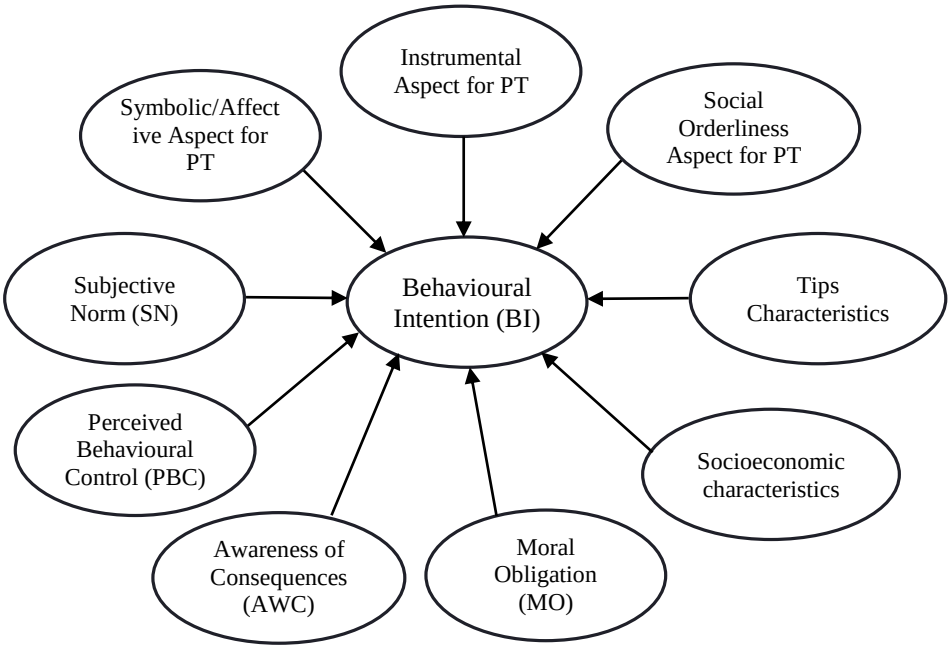


Figure 4-3: Structural model III (Extension of TPB model)

4.1.2 Modelling Structures for Traffic Safety

This study investigates the relationship between various drivers' attitudes to risky behaviours such as speeding driving, drunk driving, careless driving, distraction driving and others of risky driving and self-reported perception of riskiness of certain driving behaviours which can cause the traffic accident by using the structural equation models.

As for risk of drunk driving, we hypothesized that lack of skill awareness, lack of safety awareness, lack of law awareness, awareness of drunk driving, drinking frequency, alcohol level, and education level or knowledge of drivers will have influence on risk of drunk driving (see Figure 4-4).

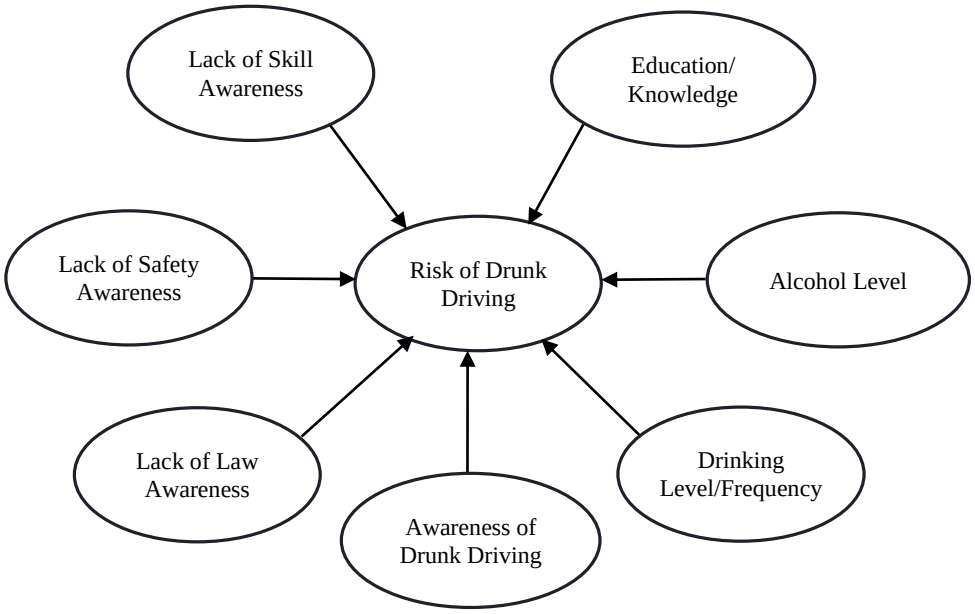


Figure 4-4: Structural model of risk of drunk driving

We also explore that distraction driving can be representative of fatigue driving, arousal driving, smoking or watching video or talking with passengers during driving, making or receiving phone call during driving. In this structure, we hypothesize that these factors will have any effects on distraction driving (see Figure 4-5).

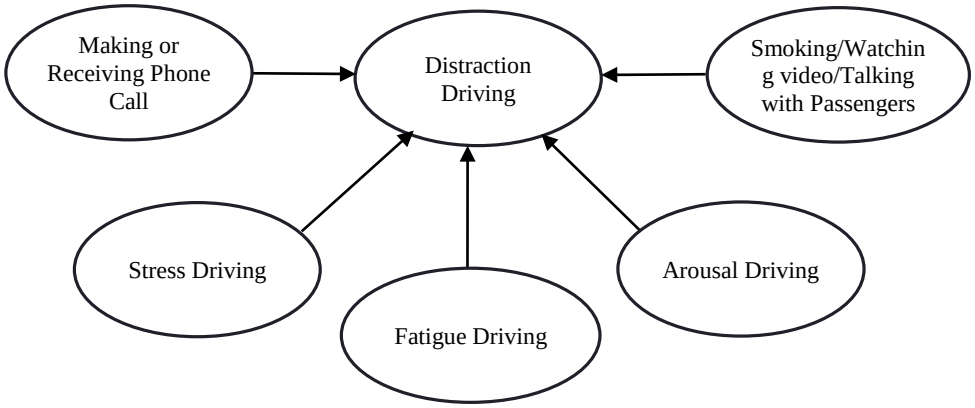


Figure 4-5: Structural model of distraction driving

Finally, we combine the above structure models into only one structural model which is the structural model of perceived of risk of traffic accident. Under this model structure, we hypothesized that drunk

driving, distraction driving, speeding driving, awareness of distraction driving and lack of punishment will have any effects on the perceived risk of accident (see Figure 4-6).

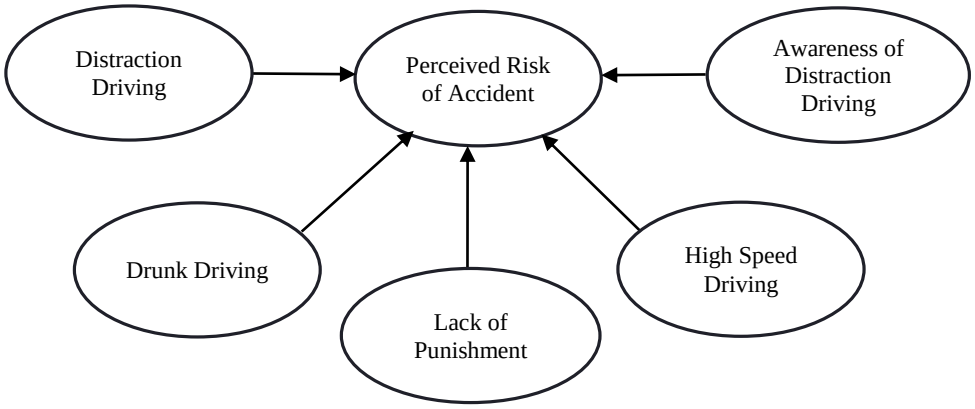


Figure 4-6: Structural model of perceived risk of accident

4.1.3 Modelling Framework

A statistical software package, SPSS and AMOS 18, is used for both the statistical analysis and structural equation modelling analysis. Figure 4-7 shows the general procedure of model development.

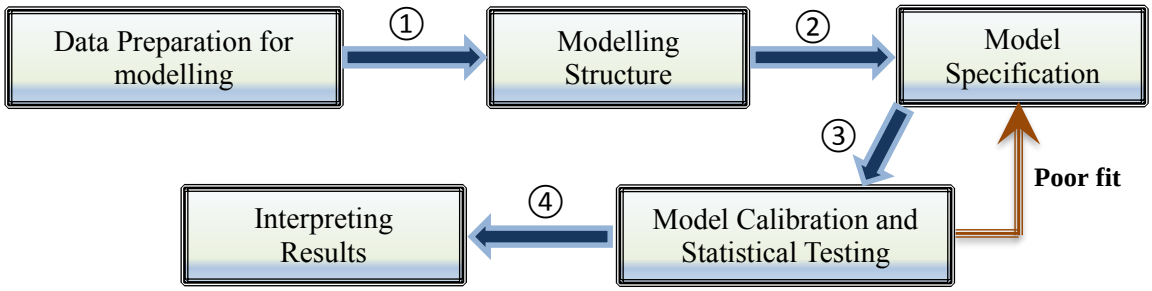


Figure 4-7: Analysis framework

4.1.3.1 Data Preparation for Modelling

Prior to modelling framework, the data obtained from the survey was cleaned and input into a single file for SPSS program. All information obtained from the survey was processed and kept in the database

(Excel sheet and SPSS program). Each piece of information was represented in a numerical form data with different types of measurement (scale, nominal, ordinal) according to its natural value. The errors and missing answers were checked and deleted before starting analysis.

4.1.3.2 Model Specification

In model construction, a number of variables were analysed based on relevant statistical test, structural equation modelling analysis and goodness of fit of the models. The psychological factors and other variables in the models were believed to be able to explain the respondents' behavioural intention towards future urban rail usage. The homogeneity of psychological questionnaires was checked by based on the value of Cronbach's alpla. It is important to find out the reliability of scale of the questionnaires to check the consistency of the constructs. Field (2005) noted that a value of 0.70-0.80 is an acceptable value of Cronbach's alpha; values substantially lower indicate an unreliable scale. Generally, the accepted value of 0.80 is appropriate for cognitive tests such as intelligent tests; for ability tests a cut-off point of 0.70 is more suitable. When dealing with psychological constructs, value below even 0.70 can realistically be expected because of the diversity of the constructs being measured. However, Choocharukul and Fujii (2007) noted that a value of the 0.6 is regarded as a lower acceptable value of the Cronbach's alpha.

In this step of analysis framework, the procedure of analysis which is showed in the flow chart of systematic procedure is used (see Figure 4-8). As for this case study, the SEM program (GRG, Evolutionary) developed in Visual Basic Application (VBA) by using the Solver function in Microsoft Excel, is used for the analysis with the estimation method of maximum likelihood. By using the Microsoft Excel 2010, the Generalized Reduced Gradient (GRG) and Evolutionary which is an algorithm for optimizing nonlinear problems are applied. GRG increases the ability of solver more powerful by changing the given initial value/constraints into the unknown. GRG Solver will take longer time to analyse since it will start with the iteration of initial value. Figure 5-8 shows the step of calculation in the developed SEM program which consist of 3 main step such as data input, Initial setup and Optimization engine. After checking the internal consistency (Cronbach's alpha index) of each latent

constructs, the data input including sample covariance, unknowns, path coefficient matrix, residual matrix and initial value and constraints are keyed. After that the initial setup is run before start running the optimization engine.

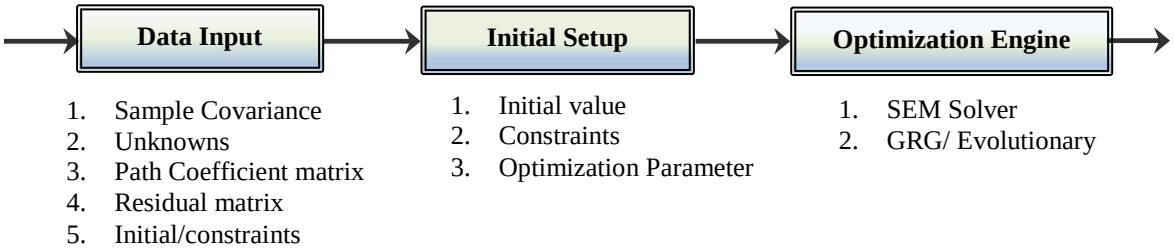


Figure 4-8: Step of Calculation in SEM program

4.1.3.3 Model Calibration

The coefficients of standardized estimates are obtained through running the structural equation modelling. Each developed model is calibrated on the basis of t-statistic value, p-value, chi-square statistics, degree of freedom, comparative fit index (CFI), normed fit index (NFI), and root mean square error of approximation (RMSEA) until the best model is obtained. For the goodness of fit of the model, the recommended acceptance of a good fit to a model requires that the obtained NFI, CFI value should be in range from 0 to 1 and for the RMSEA, the obtained values less than 0.05 indicate good fit; those ranging from 0.08 to 0.10 indicate mediocre fit and those greater than 0.10 indicate poor fit (Byrne 2009).

4.2 Numerical Stability in SEM

From the literature reviews, several problems such as the constraints of the residual, initial value and diversity of solution have been found in SEM numerical analysis (Toyoda 1998 and 2003, Kojima, 2003, Long et al. 2013). This section presents the reliability and stability on the numerical analysis in structural equation modelling and to deal with the problem on the numerical analysis such as the constraint of residual variance, initial value and the unstable and diversity of solutions results by introducing an application of the optimized calculation of genetic algorithms (GA) in structural equation modelling in

order to (1) see in more detail what is happening in the neighbourhood of the global minimum point, and examine the goodness-of-fit, validity, stability and reliability of structural model. (2) Also present a systematic procedure about what we have to keep in mind when applying SEM.

4.2.1 Analytical Methods

Four kinds of the SEM software programs are used in order to investigate the reliability of the analysis.

(1) Amos 18.0 is denoted as P1.

Amos (analysis of moment structure) version 18 by Arbuckle (2011) is distributed with SPSS. It has two components: Amos Graphics and Amos Basic. Amos Graphics permits the specification of models by diagram drawing whereas Amos Basic allows the specification from equation statements. An alternative full-information maximum likelihood estimation method for missing data is also available in Amos (Lei and Wu 2007).

(2) SEM software developed by Kojima (2003) is denoted as P2.

This SEM software is called K-Solver. Its numerical computation is calculated by using "Solver" function which is one of the add-in functions in Microsoft Excel, 2003.

(3) Our developed SEM software program is denoted as P3.

We have developed the SEM program in Visual Basic Application (VBA) by using the Solver function in Microsoft Excel, 2010. This program is more flexible; it is able to set any initial value and any constraints of residual variance and estimation weight.

(4) Optimization program by Genetic Algorithms (GA) which is denoted as P4.

Extending from SEM program P3, we have developed a new SEM program by introducing the application of optimization by GA based on GENECOP III concept (Michalewicz 1992) in order to improve the solution at the global minimum.

In the four SEM analyses program (P1, P2, P3 and P4); the numerical calculation is calculated by the Maximum likelihood method and the least-squares method. To be more concrete, when assessing population-level data- model fit for models with full and reduce sets of parameters, one starts with fit function associated with the desired method of estimation. The maximum likelihood (ML) approach will estimate by minimizing the fit function $f(\boldsymbol{\theta})$. All the solutions are based on Maximum likelihood method.

$$f(\boldsymbol{\theta}) = (N-1)\left[tr(\boldsymbol{\Sigma}(\boldsymbol{\theta})^{-1}\mathbf{S}) - \ln|\boldsymbol{\Sigma}(\boldsymbol{\theta})^{-1}\mathbf{S}| - n_x\right] \qquad (4\text{-}1)$$

Where, N: number of sample data, S: the sample covariance matrix for the observed data,

n_x: number observed variable, $\boldsymbol{\Sigma}(\boldsymbol{\theta})$: population covariance matrix implied by the model with parameters $\boldsymbol{\theta}$.

Genetic Algorithms (GA) is also applied in the analysis which is included in numerical calculation of the SEM program P4. The genetic algorithms based optimization method is used to calibrate the model parameters so that the model produces minimum error in the estimation of the variable. GA is an adaptive heuristic search algorithm premised on the evolutionary ideas of natural selection and genetic. The basic concept of GA is designed to simulate process in natural system necessary for evolution. The idea with GA is to use this power of evolution to solve optimization problems. GA has been widely studied, experimented and applied in many fields in engineering. GA provides an alternative method to solving problem, to finding optimal parameter which might prove difficult for other methods. Its usefulness and gracefulness of solving problems has made it the more favourite choice among the other methods, namely gradient search, random search and others. The concept of GENECOP which stands for genetic algorithm for numerical optimization for constrained problem was also used. This concept provides a way of handling constraints that is both general and problem independent. Based on the concept of GENECOP III, a percentile error function is used as the objective function to be minimized (Michaelwicz 1992).

Regarding the data, two samples data are used. Both sample data are gotten from the book of covariance structure analysis-structural equation modelling written by Toyoda (1998). The first sample data is an

exercise of covariance structure analysis which investigated the image of respondents' hobby which is affected by themselves and their family. Also the second data is an exercise which investigated the influence of the income, education on the social status and also the influence of social status to the social environment.

4.2.2 Constraints of Residual Variance

From the analysis result using the first sample data by running in the Amos (P1) and K-Solver (P2) without applying any constraints, it is found that the solutions of the estimated coefficient are almost the same and the residual variance have a negative value. From the Figure 4-9, it can be seen that the residual variance (e2 and e6) of the observed variable V2 and V6 are found to be negative. It can be concluded from this analysis result that this solution is not valid as the value of residual covariance is negative. In this case, setting the constraints of residual variances is required. However, the Amos and K-Solver program are not able to deal with the constraints of the residual variance; therefore SEM program (P3) will be used in the analysis.

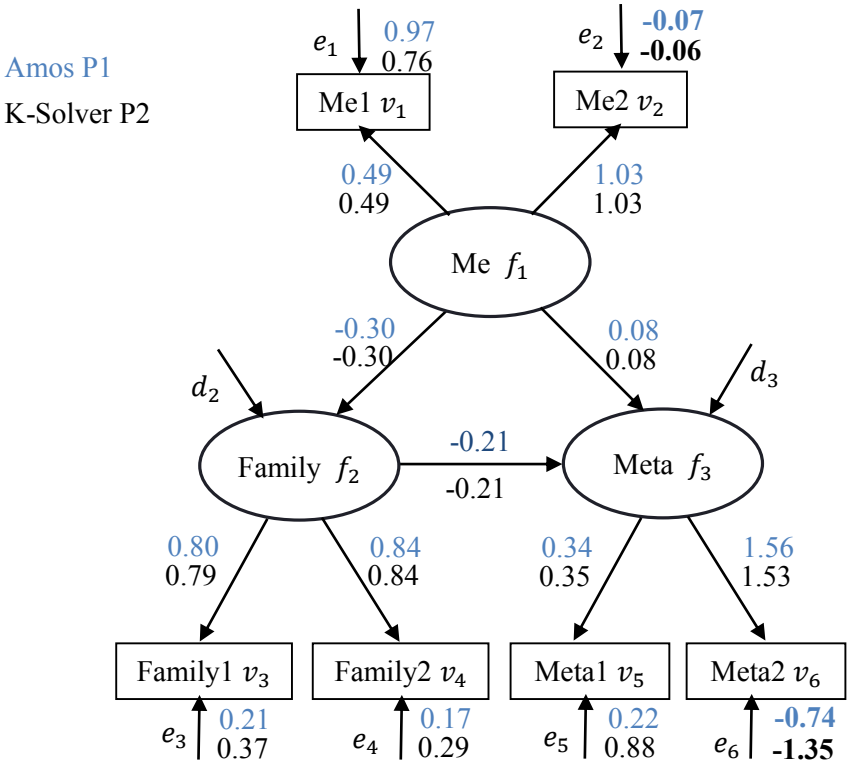


Figure 4-9: Comparison of the analysis results between SEM program P1 and P2

By setting the constraint of residual into the previous problem, given in advance the path coefficient and the residual variance of initial value are 0.5 and path coefficient is a standardized estimation and residual variance is a non-standardized estimation. It is shown that the difference of solution is found not only on the residual variance but also on the coefficient of path matrix. It can be observed that the estimated coefficient of the path matrix getting from SEM program (P3) is also changed comparing to P2. The estimated coefficients of the path matrix from both solutions of Amos without constraints (P1) and SEM program (P3) with constraints are not much differences and the solution of residual variance using P3 program is found to be positive. From these solutions, it can be said that the solution using P3 program is valid given the constraints setting and the residual variance is positive. It can be deducted that the restriction of the constraints should be considered to get more reliable solution. The results in Figure 3-3 and Figure 4-10 suggested that we could have unexpected solutions if we applied Amos (P1) and K-solver (P2) without much attention to the constraints of residual.

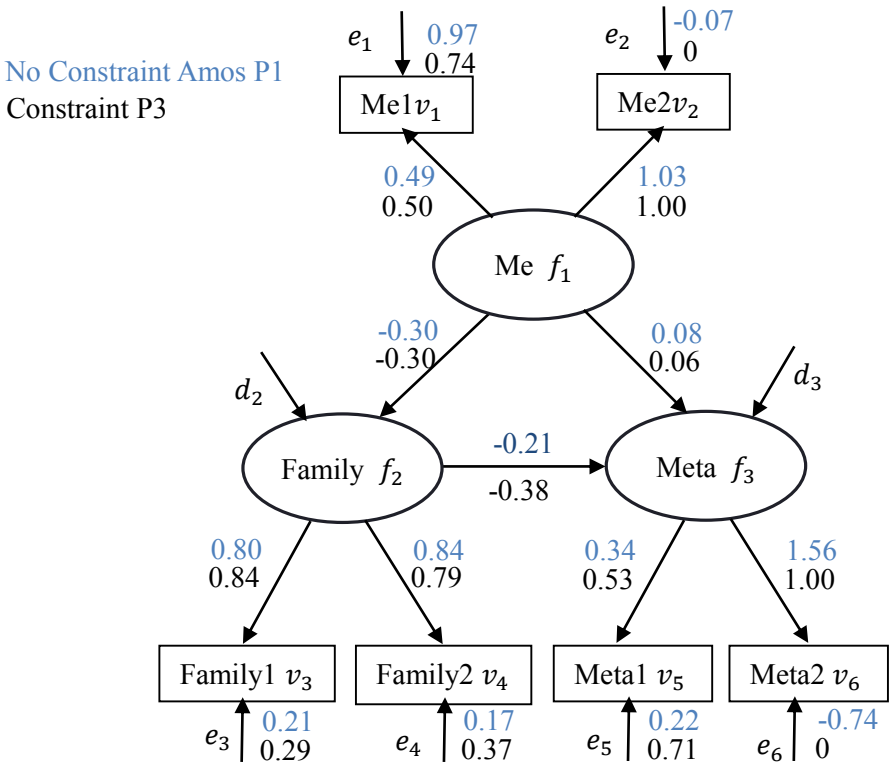


Figure 4-10: Comparison of the analysis results between SEM program P1 and P3

4.2.3 Initial Value

The initial value is also found as one of problem in SEM numerical analysis which often occurred. This analysis also uses the first sample data and SEM program P3 with two different input of initial value (shown in Table 4-1). The initial value A is given as the constant number with the value of 0.5 in both path coefficient and residual variance. Whereas the initial value B, the initial value of path coefficient is given as a random number between -1 to 1 and the initial value of residual variance is also a random number in the range of 0 to 1. It can be assumed that these initial values are the range of value which may be drawn to a solution with appropriate initial value.

Table 4-1: Value of the initial value A and B

Initial Value	Path coefficient	Residual variance
A	0.5	0.5
B	Random -1~1	Random 0~1

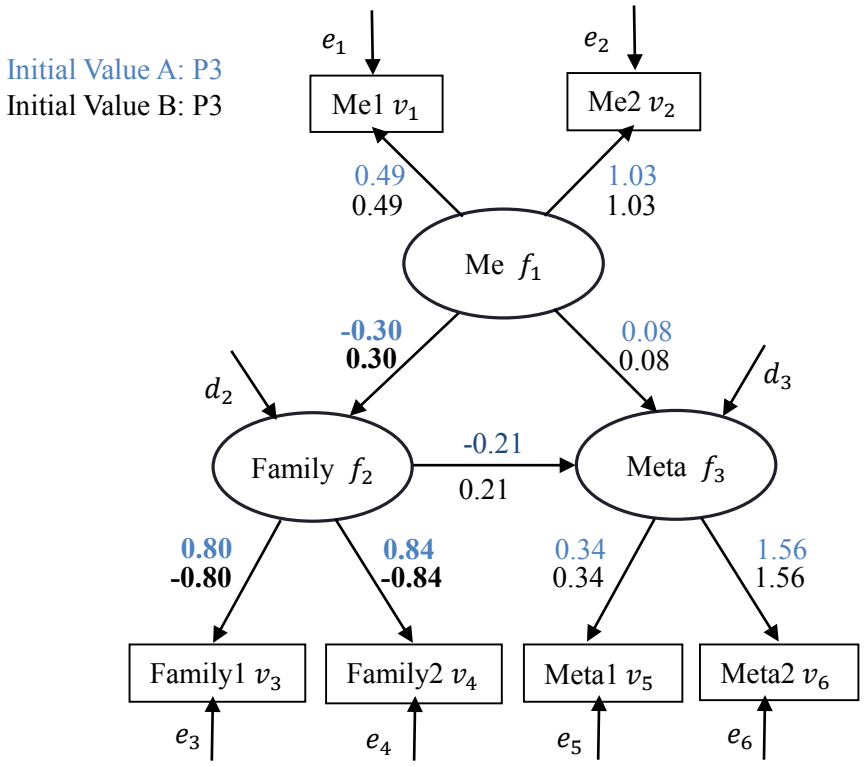


Figure 4-11: Comparison of the analysis results between initial value A and B

It is observed that the estimated coefficient of the path matrix is always reversed, when the positive or negative of the initial value is changed. From the analysis result in the Figure 4-11, it is found that the absolute value of each estimated coefficients are equal but the sign of some estimated coefficients are reversed, given the difference initial value (constant and random). As from other solution results of other structural models, it is also found that the solutions are reversed given the different initial value; moreover although initial value A is change into -0.5, the same phenomenon is occurred. It can be said that the sign of the estimated coefficient is reversed when the positive or negative of initial value is given. It can be concluded that when the positive solution is assumed, the positive initial value should be given; in contrast if the negative solution in is assumed the negative initial value should be applied. The result in Figure 4-11 suggested that we must pay much attention to the initial value.

4.2.4 Optimization Analysis by Genetic Algorithm (GA)

In order to consider the diversity and uniqueness of solution results more deeply, the genetic algorithm (GA) has been applied into SEM in this study. Some operators' value which are used in the process of GA analysis, are set as following: number of uniform mutation 20, boundary mutation 20, non-uniform mutation 40, simple crossover 20, arithmetical crossover 20, heuristic crossover 20 and other parameters are using with the default value of GA.

The SEM program P4 which is the developed program associated with GA will be used in the analysis with the second sample data. The further analysis was conducted under the various setting of conditions using in the model as show in Figure 4-12. The analysis results obtaining from P3 and P4 will be compared and discussed. It was found that even though having constraints (P3) or no constraints (P1 or P2), the value of objective functions are still wider comparing to the number of observed variables hence the solutions are found unreliable; in other words the solver solution had stopped at a local minimum. Therefore, the SEM program (P4) incorporated with GA and estimated by maximum likelihood method was proposed. The population parameter was set to 100 and the number of repetition was 10,000 times and the constraints and initial value were set as shown in Table 4-2 below.

Table 4-2: Value of the constraints and initial value

	Path coefficient	Residual variance diagonal	Residual variance non-diagonal
Constraints	-1~1	0~1	-1~1
Initial Value	0.5	0.5	0.5

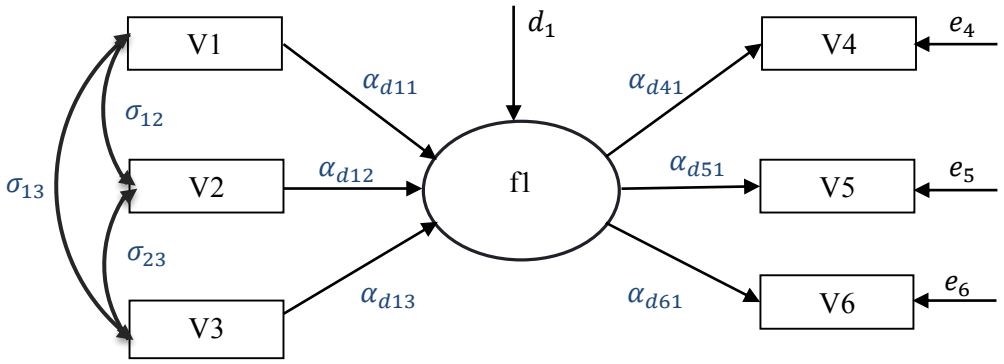


Figure 4-12: Structural model of second sample data

Figure 4-13 represents the graph showing how the value of path coefficient α_{d11} and the objective function changed with the number of iteration. The horizontal axis presents the number of time of calculation with a logarithm scale and the vertical axis on the left hand side shows the path coefficient of α_{d11} and on the right side shows the value of the objective function of the analysis model.

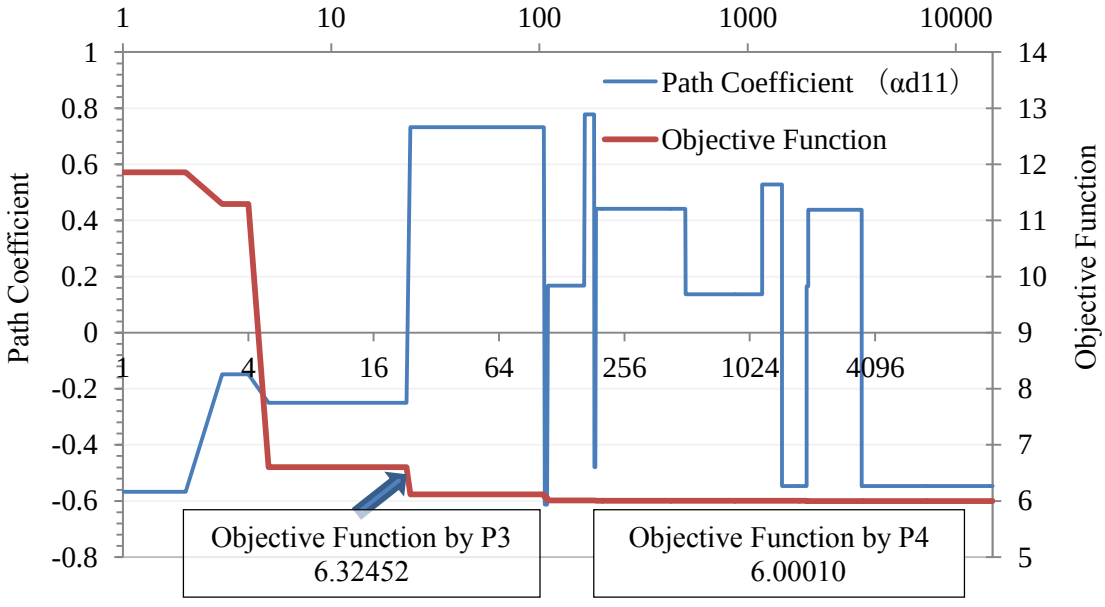


Figure 4-13: Graph of objective function and path coefficient

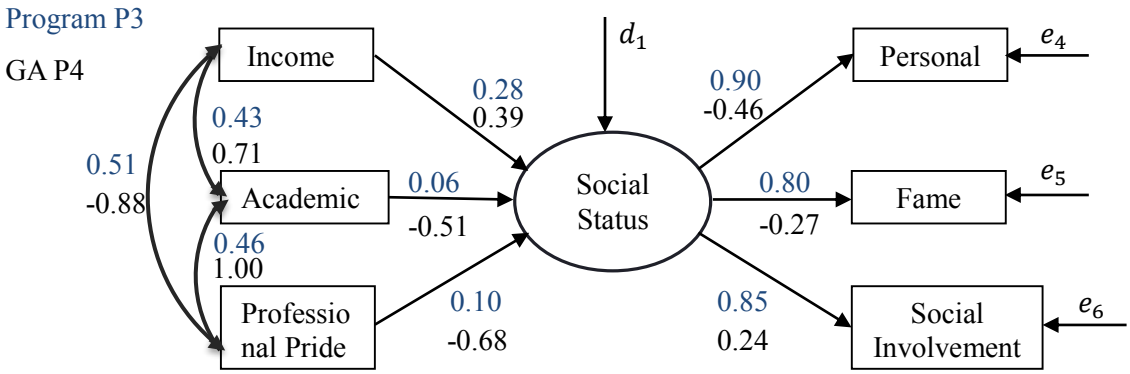


Figure 4-14: Comparison of the analysis results between P3 and P4

It can be seen from the graph that the objective function is converged after 100 times of iteration. The value of the objective function by the time of the ending calculation of P3 is 6.32452 and 6.00010 for P4. The objective function of P4 is close to the convergence yet the P3 is still far; in other words the objective function of P4 (GA) reached the global minimum but P3 (solver solution) stopped at the local minimum. The value of the path coefficient is changed rapidly hence fluctuation of path coefficient and residual variance are found. Figure 4-14 shows the comparison of the analysis results between P3 and P4. It can be conclude from the results that solver solution stopped at local minimum and sharply changed the value of path coefficient or few residual variances.

4.2.5 Summary

The problem on numerical analysis and the reference of the diversity of solution in SEM were analysed by using four kinds of SEM programs. It can be noticed that the solution of SEM is affected by the initial value, constraints and the software use. In order to get a valid and reliable analysis result, the key points below should be considered in the numerical analysis.

(1) Initial value

When a positive solution is assumed, the positive value of initial value is required; similarly if the negative solution is assumed, the negative of initial value is given. The random values of initial value either negative or positive are found ineffectiveness (should not be used).

(2) Constraints

The positive value of the constraints (0~1) is given to the diagonal of residual variance. The restriction of the constraints should be considered to get more reliable solution.

(3) GA optimization

GA program is used when the solution is far different from the assumption and also when the goodness-of-fit is found to be not good. When various solutions exist, it should be reconsidered of the sample data and model structure.

4.3 Proposed Numerical Analysis Procedure

Finally, the proposed calculation procedure is summarized into the flow chart as shown in the Figure 4-15 below. For empirical data analysis, at first we have to check the internal consistency (Cronbach's alpha index) to check the homogeneity of questionnaire items then follow the numerical analysis procedure below.

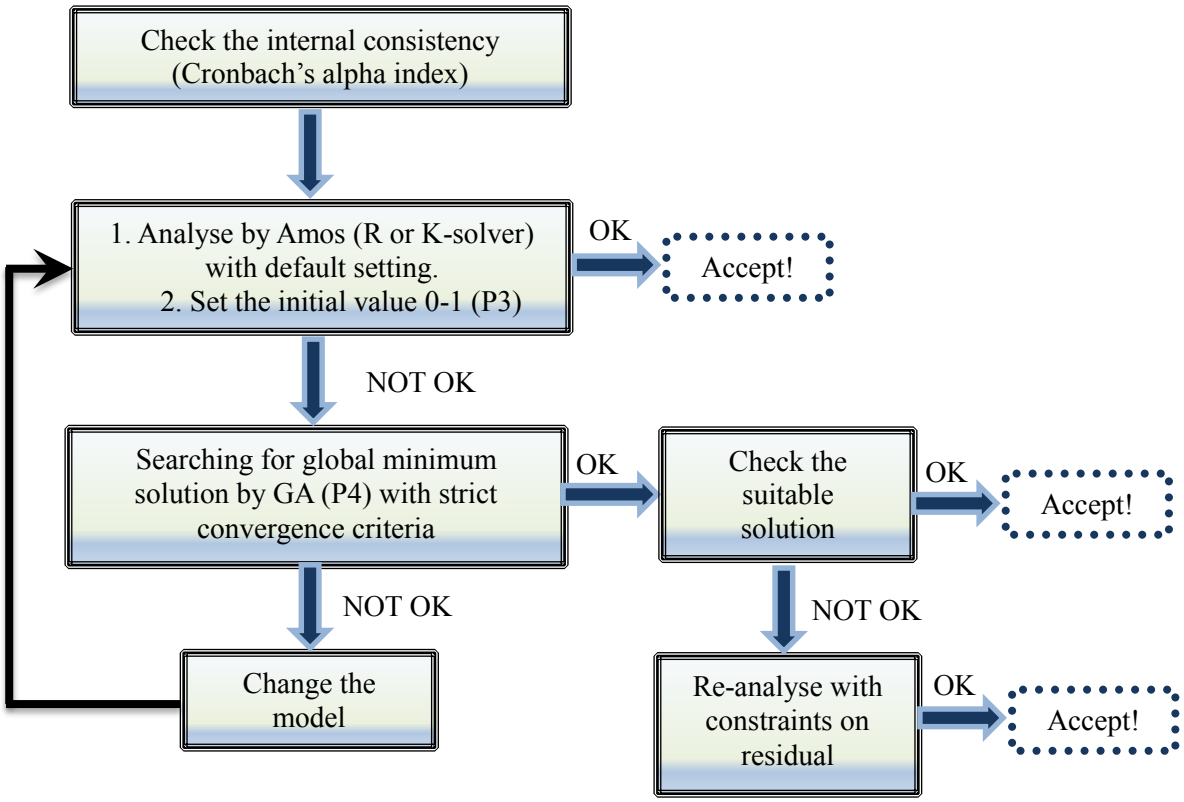


Figure 4-15: Flow chart of systematic procedure

Chapter 5

Data Collections

This chapter describes the data collection for this research study. Section 5.1 describes the questionnaire survey of theory of planned behaviour for future urban rail transport. Section 5.2 describes the questionnaire survey of drivers' attitude towards perceived risk of traffic accident.

5.1 TPB Questionnaire Survey

5.1.1 Data Collection

The data collection was done twice. First, pilot survey, was done in February, 2010 in order to test the questionnaires and to obtain the reliable result (see Appendix A). Moreover, the pilot survey is a guiding tool for the real data survey. The survey was conducted along the study line linking from Central Market in CBD to Phnom Penh International Airport (see Figure 5-1). Participants were voluntarily recruited from commuters who travel along the study line regularly and at several locations, such as schools, markets and gas stations along the study corridor.

Second, the main survey was conducted during May 27, 2010 and May 31, 2010 by 10 students from Institute of Technology of Cambodia. Before conducting the field survey, they had been trained with the developed survey forms until they fully understood how to explain the questionnaire to the respondents. The target of our survey was aimed to motorcycle riders and motor-taxi user due to this group of road users represent the highest proportion in the traffic stream and also they are more likely to change their

travel modes to the proposed sky rail line, compared with other road users such as private car users. The number of questionnaire surveys distributed was 550, and results of 398 respondents were able for data analysis.

Figure 5-1: Survey locations

5.1.2 Questionnaire Survey

To obtain information needed and to get data for the analysis of the commuter's intention toward the future urban rail transport, a set of questionnaires was designed. The survey questionnaire consists of three sections (see Appendix B). The first section asks the respondents' socioeconomic characteristics and travel characteristics, while the second section consists of psychological items used to analyse the commuter's intention toward future sky train usage. The last part of the questionnaire additionally solicits information about respondents' opinions and attitudes on the future sky train usage. To avoid error in measurement, the four-sheet survey form is done in double translation, i.e. from English to Khmer and from Khmer back to English. In addition, to facilitate a clear understanding of the future public transportation system in Phnom Penh City, some similar sky train pictures are illustrated for respondents during the survey. Similar to the pilot survey, all psychological items used in the questionnaire are measured based on a seven-point Likert scale with "Strongly disagree" and "Strongly agree" at each end point. Table 5-1 shows the psychological questionnaires in the second section of the survey questionnaire form.

Table 5-1: Psychological questionnaires

Constructs	Items	Questionnaires
Attitude (AT)	Q01	I have good feeling towards using the Sky Rail System
	Q05	For me, to use the Sky Rail System will be extremely pleasant
	Q10	For me, to use the Sky Rail System is interesting
	Q16	I would enjoy using the Sky Rail System
Subjective Norm (SN) (Descriptive)	Q07	My friends or my family will be likely to use the Sky Rail System on a regular basis
	Q17	Most people who are important to me will use the Sky Rail System on a regular basis
Subjective Norm (SN) (Injunctive)	Q15	If I take the Sky Rail System on a regular basic, my friends or my family would have no problem with it
	Q21	Most people whose opinions I value would approve my usage of the Sky Rail System on a regular basis
	Q23	Most people who are important to me think that I should use the Sky Rail System on a regular basis
Perceived Behavioural Control (PBC) (Capability)	Q03	I could use the Sky Rail System on a regular basis if I want to
	Q19	For me, to use the Sky Rail System on a regular basis is possible
Perceived Behavioural Control (PBC) (Controllability)	Q08	The decision to use Sky Rail System on a regular basis is under my control
	Q11	Whether I use the Sky Rail System on a regular basis is completely up to me
	Q14	There will be many problems and difficulties with using the Sky rail System on a regular basis
Behavioural Intention (BI)	Q04	I intend to use the Sky Rail System on a regular basis
	Q12	My intention to use Sky Rail System on a regular basis instead of my existing travel mode is strong
	Q20	I plan to use Sky Rail System on a regular basis instead of my existing travel mode
	Q22	I will make an effort to use Sky Rail System on a regular basis
Moral Obligation (MO)	Q02	Using Sky Rail System on a regular basis is the right thing to do
	Q09	I should use the Sky Rail System because it is good for the environment
	Q24	I should use the Sky Rail System because it is good for society and the city
Awareness of Consequences (AWC)	Q06	Using Sky Rail System on a regular basis will reduce traffic congestion
	Q13	Using Sky Rail System on a regular basis will reduce traffic accidents
	Q18	Using Sky Rail System on a regular basis will reduce air pollution

Other six variables, attitudinal variables, are additionally measured to quantify images of public transport from respondent's perspectives by asking them to rate their beliefs on attitudinal-aspects of public transportation. These variables are measured based on a seven-point Likert scale with a pair of adjectives, including "Boring-Exciting", "Poor-Rich", "Inconvenient-Convenient", "Slow-Fast", "Destructive-Constructive", and "Environmental damaging-Environmental friendly" (see Table 5-2). The sample size of surveys were followed based on TPB and SEM sampling. As a result, a total number

of 398 respondents were collected for the main survey. The characteristics of the sample will be described in chapter six.

Table 5-2: Attitudinal aspects' questionnaires

Future urban rail system								
	1	2	3	4	5	6	7	
Boring								Exciting
Poor								Rich
Inconvenient								Convenient
Slow								Fast
Destructive								Constructive
Environmental Damaging								Environmental Friendly

5.2 Questionnaire Survey of Drivers' Attitudes

5.2.1 Data Collection

The data collection was done into two ways: internet base and paper base. This is the first time to test whether the data collection through the internet from Cambodian people is possible or not. The link of questionnaire survey was shared in Facebook or from friends to friends. For the paper questionnaires survey was conducted by 8 surveyors from the Institute of Technology of Cambodia, who have been trained and fully understand the questionnaire survey. The survey was conducted from December 01, 2012 to December 03, 2012 for a total of three days at several locations such as schools, workplaces, markets, gasoline stations and others. Participants are randomly recruited from drivers who travel along the roads in Phnom Penh city. They will be asked to stop and complete the questionnaires. A total of 250 of questionnaire surveys were collected and 231 respondents are useable for data analysis.

5.2.2 Questionnaire Survey

The questionnaire survey is designed based on the psychological construct to measure the drivers' attitudes, perception and their behaviour towards various risky driving behaviour. The survey questionnaire is divided into three sections (see Appendix C). The first section asks the respondents

about their socioeconomic characteristics and travel characteristics. The second section consists of the questions regarding to the drivers' attitude and behaviour of drinking driving and the last section asks the respondents about their careless driving and distraction driving behaviours. The questionnaire survey is done in double translation which is from English to Khmer and from Khmer to English in order to avoid the errors in measurement. The questionnaires are measured base on a five-point Likert scale with "strongly disagree" and "strongly agree" at each end point and provided answers. Table 5-3 shows some questionnaires which are used to measures the drivers' attitudes and other psychological questionnaires.

Table 5-3: Some psychological questionnaires to measure drivers' attitudes

Constructs	Items	Questionnaires
Drinking frequency	Q01	How often do you have a drink containing alcohol?
	Q02	How many days per week do you drive after drinking even a small amount of alcohol?
Drinking level	Q03	How many standard drinks containing alcohol do you have on a typical day when you are drinking?
	Q04	How often do you have six or more drinks on one occasion?
Lack of safety awareness	Q05	I think that driving after a little drinking of alcohol is ok.
	Q06	I think that driving for a short distance after drinking alcohol is ok.
Lack of law awareness	Q07	I think that law of drunk driving should be made more severe.
	Q08	I think that the control of drunk driving should be increased.
Lack of skill awareness	Q09	Despite driving under the influence of alcohol, it would not cause accident.
	Q10	I think that judgment/reaction behaviour will be lower if driving under the influence of alcohol.
Risk of drunk driving	Q11	I think that drunk driving is bad manner and dangerous.
Awareness of drinking driving	Q12	If I drink alcohol, I use public transport (current mode of public transport).
	Q13	If I drink alcohol, I will use public transport (future mode of public transport).
	Q14	If I drink alcohol, I will not drive any vehicle.
	Q15	If I joined a party and I were a driver, I would not drink alcohol even though friend or other important people ask me to drink.
Distraction driving	Q16	I think that making or receiving phone call during driving is bad.
	Q17	I think that stress driving is dangerous and may cause the traffic accident.
	Q18	I think that fatigue driving/arousal driving is dangerous and risk of causing traffic accident
	Q19	I think that it would be risky and dangerous if smoking/watching video during driving.
Awareness of distraction driving	Q20	I think that I should not drive in the condition of arousal, stress, fatigue.
	Q21	I think that I should not pick up or make phone call during driving.
Perceived risk of traffic accident	Q22	I think that high speed driving/over taking in city is dangerous and may cause traffic accident.
	Q23	I think that driving with unchecked vehicle/old vehicle is dangerous and risk of causing traffic problems.
	Q24	I think that it would be risky and dangerous if driving without wearing helmet or fastening seat-belt.
	Q25	I think that it would be risky and dangerous if driving under the influence of alcohol.

Chapter 6

Results for Public Transport

This chapter summarizes the descriptive statistics of questionnaire survey of future urban rail transport, the results of analysis models and discussion of each models. Section 6.1 summarizes the descriptive statistics of respondents including the socioeconomic characteristics, trip characteristics, descriptive of psychological questionnaire. Section 6.2 shows the results of analysis models and section 6.3 overviews the discussions of commuters' behavioural intention to use future urban rail transit.

6.1 Descriptive Statistics

6.1.1 Socioeconomic Characteristics

Table 6-1 summarizes the socioeconomic characteristics obtained from the main questionnaire survey. Approximately 75 percent of respondents are male. About 67 percent of the total respondents are in range of 18-25 years old; 19.7 percent are in range of 26-25 years old; 10.6 percent are in range of 36-50 years old and 2.6 percent are in range of 51-70 years old. In terms of occupation, 59 percent of the total respondents are students; 14 percent are employees; 12 percent are civil servants and the rest are teachers, sellers, unemployed and others. It can be seen that 53.5 percent of the respondents have no monthly income, presumably the students; 18.1 percent have monthly income smaller than $100 and approximately, 20 percent of total respondents have in range of $101-$200. From the survey, the size of the households range from 1 to 12 people. A majority of the respondents are from the household with 5 members. The average of household size is 5.44 with the standard deviation of 1.86.

Table 6-1: Summary of socioeconomic characteristics

Variable	Percentage
Gender	Female (24.6); Male (75.4)
Age	18-25 years old (67.0); 26-35 years old (19.7) 36-50 years old (10.6); 51-70 years old (2.6)
Occupation	Student (59.0); Teacher (3.8); Employee (13.8) Seller (7.8); Civil Servant (11.8); Unemployed (1.0); Others (2.8)
Education	Primary school (3.0); Secondary school (8.3); High school (19.1) Associate Bachelor (11.1); Bachelor (55.3); Higher than Bachelor (3.3)
Income	None (53.5); <=$100 (18.1); $101-$200 (19.8); $201-$300 (3.5) $301-$400 (2.0); $401-$500 (2.3); >=$500 (0.8)
Household member	<=2people (3.6); 3 people (9.3%); 4 people (18.7); 5 people (23.0); 6 people (20.7); 7 people (11.6); 8 people (7.3); >=9 people (5.9)

Figure 6-1 summarizes the number of vehicles in the household. It can be seen that the majority of the respondents have no car in their household which accounts for 71.80 percent of the total respondents and nearly 45 percent of the total respondent have at least one motorcycle in their household; 27.10 percent of respondents have 2 motorcycles in their household; 18.60 percent have 3 motorcycles and 9.80 percent possess more than 4 motorcycles in their household.

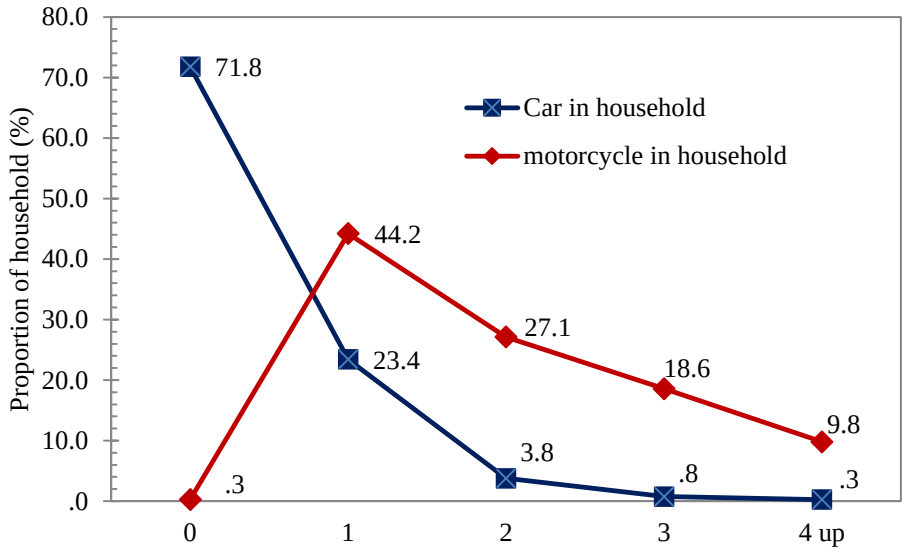


Figure 6-1: Summary of number of vehicle in household

6.1.2 Trip Characteristics

Table 6-2 and Figure 6-2 present the distribution of the trip characteristics. From Table 5-2, it can be seen that approximately 89 percent of the total respondents have availability to use their vehicles when they want to. Approximately, 44 percent of the total respondents have a driving license whereas another 56 percent have no driving license. In terms of private vehicle usage, it can be found the majority of respondents used their private vehicle during last 4 weeks which accounts for 88.3 percent of the total respondents.

Table 6-2: Trip characteristics

Variable	Levels	Percentage
Vehicle availability	Available	88.9
	Not available	11.1
Driving license	Have	43.7
	Not have	56.3
Private vehicle usage	0-50%	11.7
	51-100%	88.3

Figure 5-2 shows respondents' current trips characteristics in terms of trip mode (a), cost (b), time (c), and distance (d). It can be seen that about 90 percent of the total respondents use their own motorcycles while 3.8 percent use motor-taxi and another 6.3 percent use other modes of transports, presumably private cars or bicycles.

Approximately, 92 percent of the total respondents make their trips a distance of about 3 to 10 Kilometres, 7 percent from 11 to 20 Kilometres and 1.3 percent from 21 to 30 Kilometres. About 57 percent of the total respondents spend about 500 to 2,000 Riel per trip followed by 2,100 to 4,000 Riel (31.9 percent), 4,100 to 5,000 Riel (5.9 percent) and 5,100 to 10,000 Riel (4.9 percent). In terms of travel time, nearly half of respondents take around 11 to 25 minutes to reach their destination; 3 to 10 minutes (28.2 percent); 26 to 45 minute (22.4 percent) and 46 to 60 minutes (1 percent).

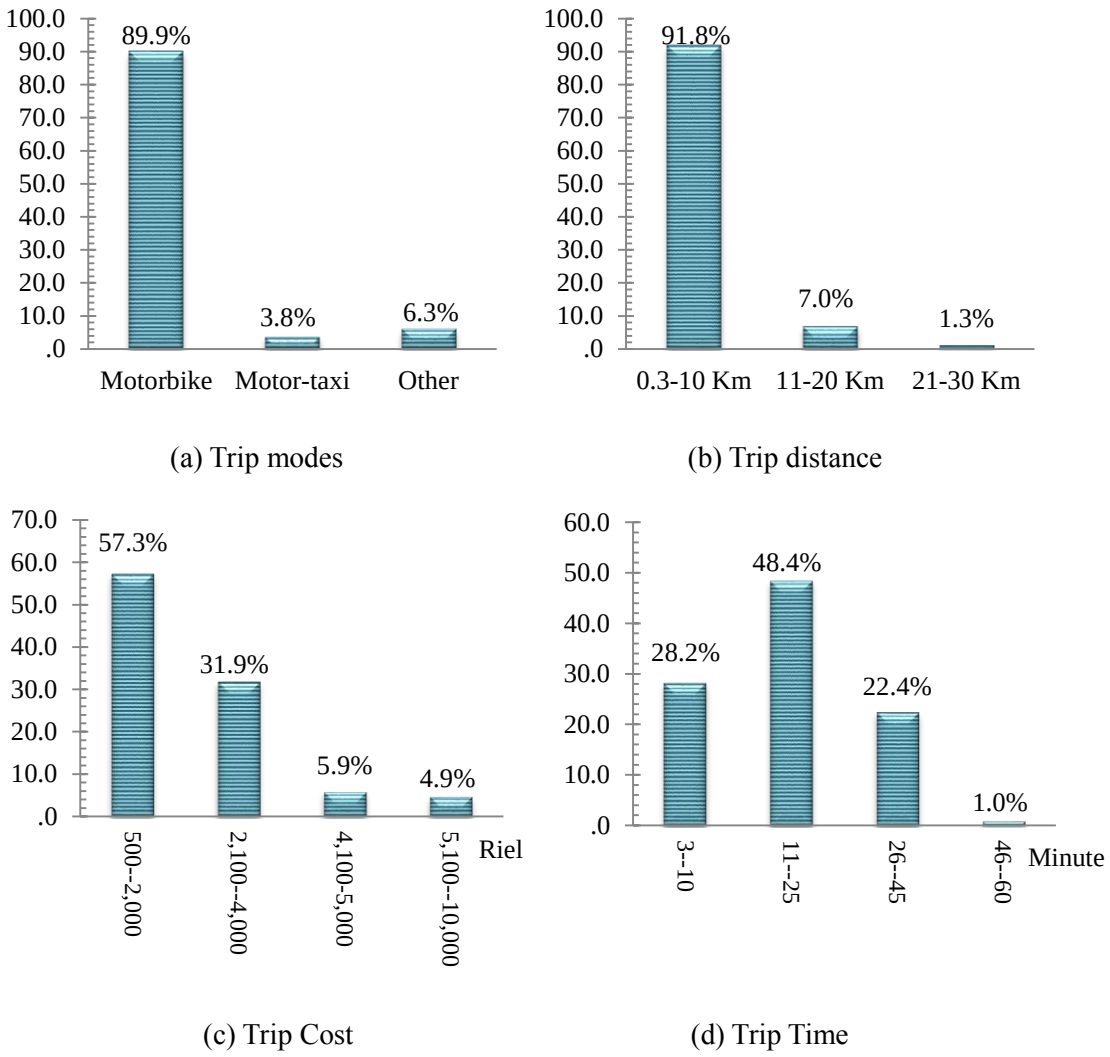
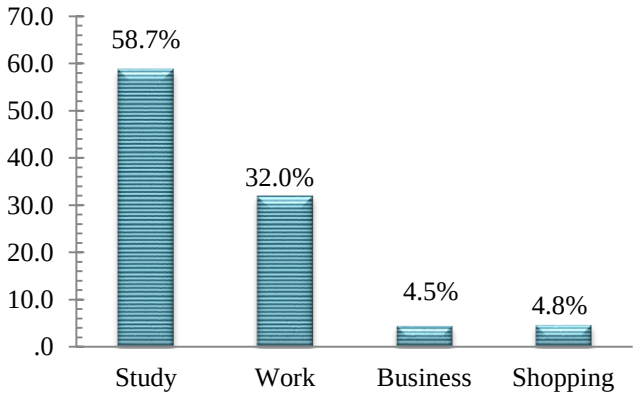


Figure 6-2: Distributions of trip characteristics

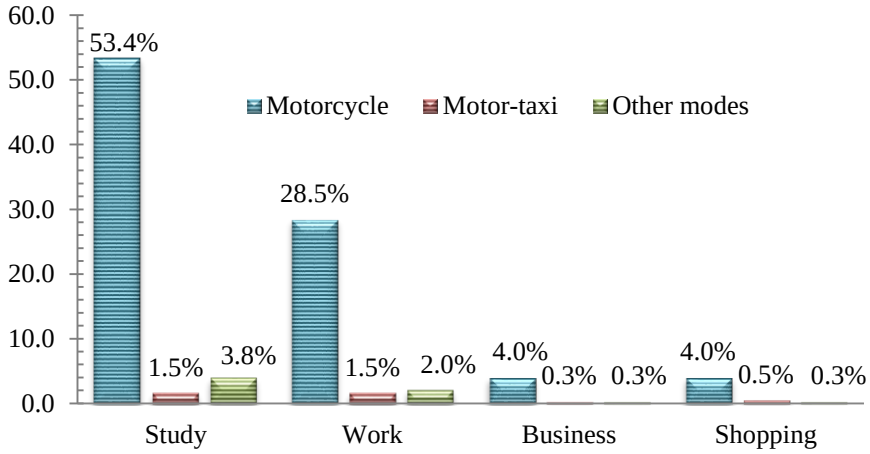
Figure 6-3 illustrates the distributions of trip purpose in terms of study, work, business, and shopping. From the Figure 6-3(a), it can be seen that 58.7 percent of the total respondents are study trips followed by 32 percent (work trip), 4.5 percent (business trip) and 4.8 percent (shopping trips). Motorcycle is the predominant mode of transportation for all trips purpose such as study, work, business and shopping (see Figure 6-3 (b)).

Table 6-3 shows the frequency of transportation modes usage corresponding to the respondents' commute trips. The data were getting by asking respondents about their transportation modes used during the previous week. From the table, it can be seen that about 76 percent of the total respondents

used motorcycle as their commute mode every day. More than half of the respondents have stated that they never used private cars, motor-taxi or bicycles as their commute modes during the previous week. On the other hand, 26.6 percent of the total respondents rarely used motor-taxi during the previous week, i.e. they probably used other transportation modes or they did not travel often during the previous week.



(a) Trip purpose



(b) Study, work, business and shopping trips

Figure 6-3: Distributions of trip modes

Table 6-3: Frequency of mode usage

Mode	Everyday	4-5 days/week	2-3 days/week	Rarely	Never
Private car	3.0	1.0	1.5	5.6	88.9
Motorcycle	75.6	12.1	3.5	4	4.8
Motor-taxi	0.5	1.3	2	26.6	69.6
Bicycle	5.1	1.3	3	13.7	76.9

6.1.3 Descriptive of Psychological Questionnaires

Table 6-4 and Figure 6-4 summarized the respondent's response on attitude variable. It shows the percentage of seven-point Likert scale, mean and standard deviation value for four attitudinal statements. It can be observed from the Table 6-4 that most of the respondents have positive feeling to use future sky train. On the average, 38.5 percent of the total respondents prefer selecting the highest scale of number (number 7). About 92 percent of the total respondents give the scale number bigger than 4. In terms of mean, it can be denoted that the first statement of attitude give the value of 6.25 with the standard deviation 1.00 followed by second statement (5.87 with dev. 1.13), third statement (5.97 with the standard deviation 0.99) and forth statement (5.94 the standard deviation 1.07). Overall, respondents seem to have a good feeling toward future sky train usage providing the average mean of attitudes mostly bigger than 5. Figure 6-4 shows the percentage of seven-point Likert scale in form of bar chart.

Table 6-4: Percentage, mean and standard deviation of attitudes

Code	Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
		1	2	3	4	5	6	7		
AT1	Q01	0.30	0.80	0.80	4.80	10.60	30.90	52.00	6.25	1.00
AT2	Q05	1.00	0.80	1.80	5.50	21.60	35.90	33.40	5.87	1.13
AT3	Q10	0.30	0.50	1.00	6.00	18.30	39.90	33.90	5.97	0.99
AT4	Q16	0.50	0.80	1.50	6.30	17.80	38.40	34.70	5.94	1.07

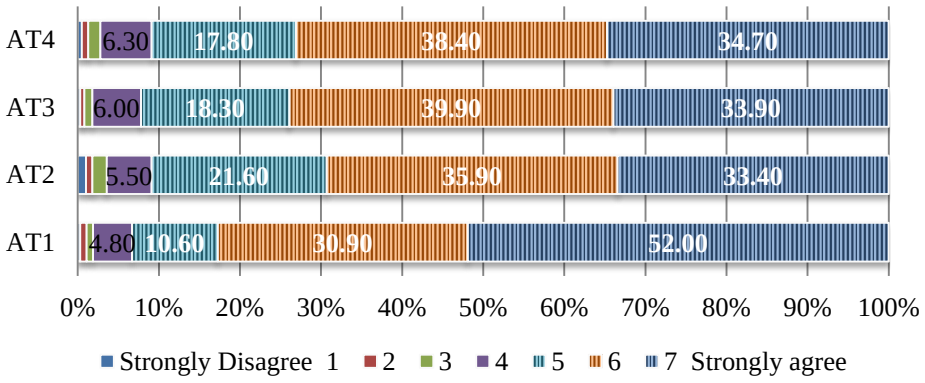


Figure 6-4: Percentages of attitude statements

From Table 6-5, it can be observed that respondents strongly agree with the first statement of the subjective norm (SN1) giving the mean of 5.49 with the standard deviation of 1.35. Similarly to the second question, SN2 have the mean value of 5.32 with standard deviation of 1.53, SN3 (5.32 with standard deviation of 1.41), SN4 (5.67 with standard deviation of 1.21) and SN5 (5.59 with standard deviation of 1.39), respectively. In terms of mean, it can be seen that the mean of each subjective norm statements are pretty much the same value. It means that the respondents are more likely to use the future sky train depending on their family or friend. It can be seen from Figure 6-5 that about 79 percent of the total respondents strongly agree to use future urban rail transit because of their family or friend and other people who are important to them.

Table 6-5: Percentage, mean and standard deviation of subjective norms

Code	Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
		1	2	3	4	5	6	7		
SN1	Q07	2.00	1.80	4.00	13.80	16.60	39.20	22.60	5.49	1.35
SN2	Q15	3.80	3.80	4.30	11.60	19.10	36.40	21.10	5.32	1.53
SN3	Q17	3.00	1.50	4.80	14.60	23.60	32.20	20.40	5.32	1.41
SN4	Q21	0.50	1.30	3.30	11.80	19.30	36.20	27.60	5.67	1.21
SN5	Q23	1.50	2.80	3.80	11.80	16.60	33.70	29.90	5.59	1.39

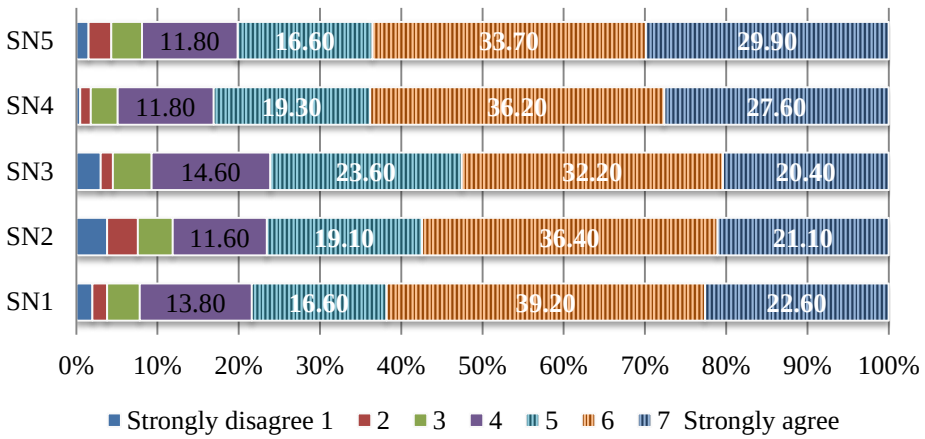


Figure 6-5: Percentages of subjective norm statements

Perceived behavioural control (PBC) was measured by asking respondents to rate four statements. Table 6-6 shows the percentage of Likert scale, mean and standard deviation of PBC. It can be seen that the

respondents strongly agree with the first statement of PBC (PBC1) than other statements. Figure 6-6 shows the percentage in form of bar chat. It can be quickly seen that almost all respondents strongly agree. On the average, the mean of PBC is 5.68 with the average of standard deviation of 1.31. It means that respondents feel able to use future sky train.

Table 6-6: Percentage, mean and standard deviation of PBC

Code	Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
		1	2	3	4	5	6	7		
PBC1	Q03	1.80	1.50	2.80	4.80	18.30	38.40	32.40	5.81	1.26
PBC2	Q08	2.30	0.80	2.50	9.00	19.80	35.90	29.60	5.69	1.29
PBC3	Q11	2.30	1.80	2.30	9.80	19.30	33.40	31.20	5.67	1.35
PBC4	Q19	1.50	2.80	3.80	8.30	23.60	36.40	23.60	5.53	1.32

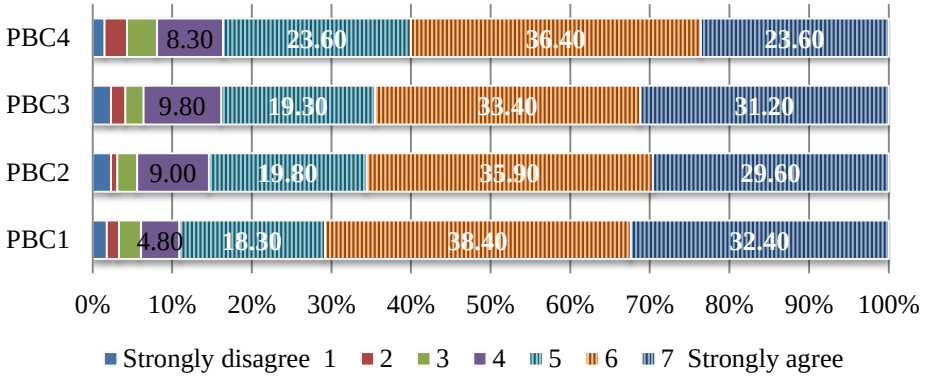


Figure 6-6: Percentages of perceived behavioural control statements

Table 6-7 and Figure 6-7 summarized the respondent's response on awareness of consequence variable. It can be observed that respondents strongly agree these 3 statements of AWC with the following value of the mean 6.36 (AWC1), 6.16 (AWC2), and 5.98 (AWC3). From the Figure 4.10, it can be easily seen that these 3 statements have the high percentage of agreement to use future sky train giving the awareness of consequence.

From Table 6-8 and Figure 6-8, it can be easily seen that the respondents do agree with the measured statements with the average of mean 5.97 and standard deviation of 1.15. It can be seen that the respondents more strongly agree with the third statement of the moral obligation (MO3) than other

statement with the mean of 6.41 and standard deviation of 0.99 followed by second statement (MO2) (mean of 6.06 and standard deviation of 1.06) and first statement (MO1) (mean of 5.43 and standard deviation of 1.39).

Table 6-7: Percentage, mean and standard deviation of awareness of consequences

Code	Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
		1	2	3	4	5	6	7		
AWC1	Q06	0.30	0.00	2.00	1.50	9.00	32.20	55.00	6.36	0.90
AWC2	Q13	0.30	1.00	1.00	4.30	12.10	36.20	45.20	6.16	1.02
AWC3	Q18	0.50	1.00	2.80	4.30	15.30	38.70	37.40	5.98	1.11

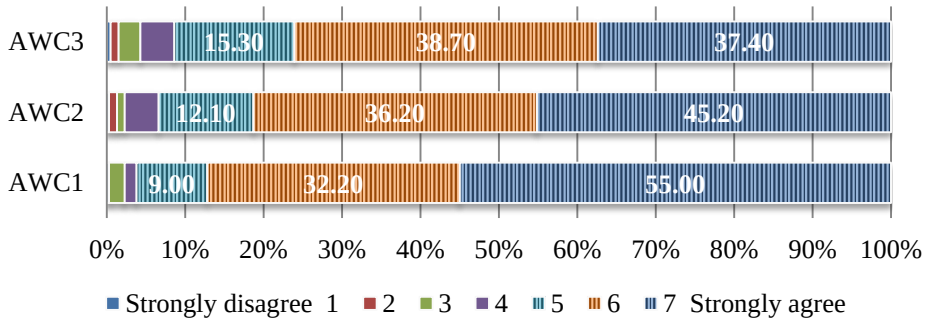


Figure 6-7: Percentages of awareness of consequences statements

Table 6-8: Percentage, mean and standard deviation of moral obligation

Code	Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
		1	2	3	4	5	6	7		
MO1	Q02	2.50	3.00	3.30	10.30	22.40	37.70	20.90	5.43	1.39
MO2	Q09	0.80	0.30	1.80	3.80	17.60	34.20	41.70	6.06	1.06
MO3	Q24	0.50	0.80	1.00	2.30	9.50	22.40	63.60	6.41	0.99

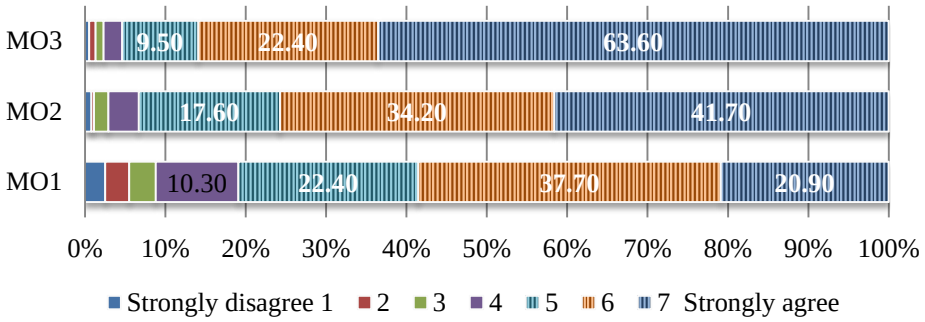


Figure 6-8: Percentages of moral obligation statements

It can be denoted from Table 6-9 and Figure 6-9 that the percentage of these four statements is pretty much the same. Approximately 10 percent of the total respondents are neutral and mostly the rest of the total respondents strongly agree to use future sky train. Regarding to the mean of the behavioural intention, all statements are in value more than 5. In other words, the respondents have likely intent to use future sky train.

Table 6-9: Percentage, mean and standard deviation of behavioural intention

Code	Item No.	Strongly disagree → Strongly agree							Mean	Std. Dev.
		1	2	3	4	5	6	7		
BI1	Q04	3.80	1.80	3.80	12.80	18.30	36.40	23.10	5.42	1.47
BI2	Q12	3.30	3.30	3.80	13.30	25.40	32.70	18.30	5.26	1.45
BI3	Q20	1.80	3.50	4.30	11.30	25.10	35.20	18.80	5.35	1.37
BI4	Q22	0.80	1.50	5.80	9.30	22.10	31.20	29.40	5.61	1.30

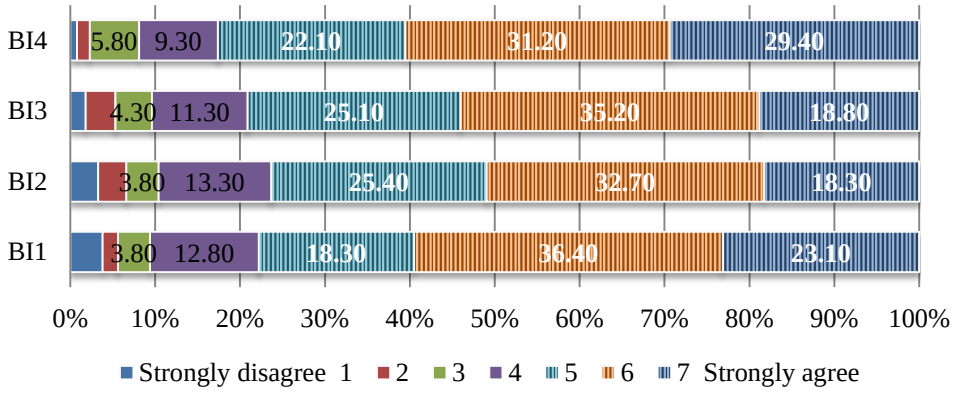


Figure 6-9: Percentages of behavioural intention statements

6.1.4 Descriptive of Respondents' Opinion on Sky Rail System

Results from the third section of the questionnaire form are summarized here. In that section we asked the respondents to give their opinion and their image on the future urban rail system as well as their current mode usage. From Table 6-10, it is found that 40.8 percent of the total respondents used to hear about the sky rail system whereas 59.2 never hear about that. About 52 percent of the respondents stayed from the sky rail system about 1 Kilometre, 40 percent about 1 to 5 Kilometres and 7.70 percent of those respondents stayed further than 5 Kilometres. Most of the respondents are willing to use the sky rail

system when it is available in the future. Approximately, 31 percent of them are willing to pay less than 1,000 Riel, 35 percent are willing to pay in range of 1,000-2,000 Riel, 26.40 percent are willing to pay from 2,100 Riel to 4,000 Riel and 7.20 percent are willing to pay more than 4,000 Riel, respectively. About 67 percent of the total respondents are willing to take 10 minutes for their trip, 11-30 minutes (32.50 percent) and more than 30 minutes (0.80 percent), respectively.

Table 6-10: Summary of respondent's opinion and willingness

Variable	Percentage
Awareness	Yes (40.8); No (59.2)
Distance from House to SRS	0-1Km (52.3); 1-5Km (40.0); > 5Km (7.7)
Willing to pay	<1,000 Riel (31.3); 1000-2,000 Riel (35.0); 2,100-4,000 Riel(26.4); > 4,000 Riel (7.2)
Willing time	1-10 minutes (66.8); 11-30 minutes (32.5); > 30 minutes(0.8)

Also in section 3 of the questionnaire survey, three questions are used to ask the respondents to rate about their opinions on the sky rail system. Those questions are: *"How likely will you use the sky rail system on a regular basis?"; "Do you think the sky rail system will help alleviating traffic congestion in Phnom Penh?" and "Do you think the sky rail system will help alleviating pollution issue in Phnom Penh?"*. Table 6-11 summarizes the respondents' willingness to use sky rail system. It is found that 1.50 percent of the total respondents are very unlikely to use sky rail system, 2 percent are unlikely, 14.10 percent are not sure, 48.70 percent are likely and 33.70 percent are very likely to use sky rail system.

Table 6-11: Summary of respondent's willingness to use SRS

Variable	Levels	Percentage
Willingness to use SRS	Very unlikely	1.50
	Unlikely	2.00
	Not sure	14.10
	likely	48.70
	Very likely	33.70

Table 6-12 and Table 6-13 represent the cross table between the occupation and willingness to use sky rail system and willingness to pay of the respondents. It can be seen that students are more likely to use

sky rail system than the other road users such as employee, civil servant, seller, teacher, unemployed and others. Most of respondent are willing to pay from 1,000 Riel to 2,000 Riel (see Table 6-13).

Table 6-12: Respondent's willingness to use SRS

Occupation	**Willingness to use SRS**					**Total**
	Very unlikely	Unlikely	Not sure	Likely	Very likely	
Student	5	6	38	119	67	235
Teacher	0	0	0	7	8	15
Employee	1	1	5	27	21	55
Seller	0	0	5	12	14	31
Civil servant	0	1	6	23	17	47
Unemployed	0	0	1	1	2	4
Other	0	0	1	5	5	11
Total	6	8	56	194	134	398

Table 6-13: Respondent's willingness to pay

Occupation	**Willingness to pay**				**Total**
	< 1,000 Riel	1,000-2,000 Riel	2,100-4,000 Riel	> 4,000 Riel	
Student	81	86	46	13	235
Teacher	1	6	7	1	15
Employee	19	17	15	4	55
Seller	4	8	13	3	31
Civil servant	11	14	15	7	47
Unemployed	3	1	0	0	4
Other	2	3	6	0	11
Total	121	135	102	28	398

Table 6-14 represents the percentage, mean and standard deviation of respondents' opinion on traffic congestion and pollution. In term of bar chat, most of respondents think that the sky rail system will help alleviating both traffic congestion and pollution issue in Phnom Penh city (see Figure 6-10). In term of means, the majority of the respondents have positive opinion on the sky rail system (see Table 6-14).

Table 6-14: Percentage, mean and standard deviation of respondent's opinions

If SRS was available, respondents' opinion on:							
Statement	**1**	**2**	**3**	**4**	**5**	**Mean**	**S.D.**
Traffic congestion	0.50	2.00	7.10	45.10	45.30	4.32	0.73
Pollution	2.00	4.30	10.60	43.10	40.10	4.15	0.91

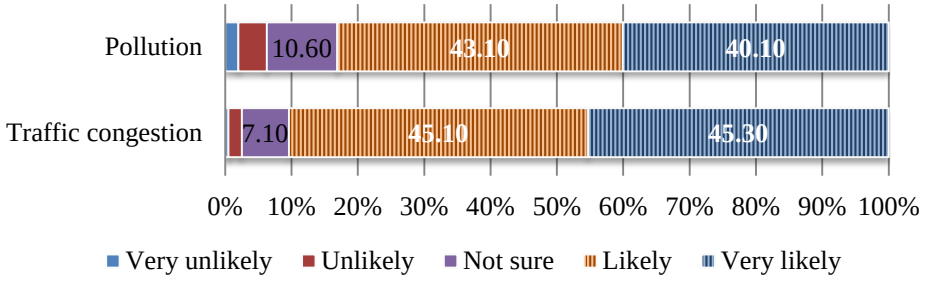


Figure 6-10: Percentages of respondents' opinion statements

6.1.5 Attitudinal-aspect Variables

Attitudinal-aspect variables are additionally measured to quantify images of public transport from respondent's perspectives by asking them to rate their beliefs on attitudinal-aspects of future public transportation mode. These variables are measured based on a seven-point Likert scale with a pair of adjectives including, "Boring-Exciting", "Poor-Rich", "Inconvenient-Convenient", "Slow-Fast", "Destructive-Constructive", and "Environmental damaging-Environmental friendly" (Choocharukul, Tan and Fujii, 2006). Table 6-15 and Figure 6-11 summarizes the respondent's response on attitudinal aspects. It can be seen from table that respondents seem to have positive feeling on the future sky train mode. The first statement of the attitudinal aspects variables is measured by asking the respondents to rate the statement of the pair adjectives "boring-exciting" on the future sky train. It is found that the mean of the first statement has the value of 6.08 with the standard deviation 1.13 followed by the second statement, "poor-rich" (mean 5.30 and standard deviation 1.40); third statement, "inconvenient-convenient" (mean 6.04 and standard deviation 1.04); forth statement, "slow-fast" (mean 5.98 and standard deviation 1.14); fifth statement, "destructive-constructive" (mean 6.13 and standard deviation 0.99); and sixth statement, "environmental damaging-environmental friendly" (mean 6.31 and standard

deviation 1.12). It can be seen quickly from Figure 4.13 that the majority of the respondent give positive attitudinal aspect towards future sky train usage.

Table 6-15: Percentage, mean and standard deviation of attitudinal-aspects

Future Sky Train									
Attitudinal factors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Mean**	**SD.**
Boring-exciting	0.80	0.50	2.30	4.50	16.80	27.90	47.20	6.08	1.13
Poor-rich	2.00	1.30	2.50	29.40	12.10	28.90	23.90	5.30	1.40
Inconvenient-convenient	0.80	0.00	1.50	5.50	15.10	38.70	38.40	6.04	1.04
Slow-fast	0.80	0.80	1.00	8.00	16.10	32.70	40.70	5.98	1.14
destructive-constructive	0.50	0.30	1.00	4.80	13.60	37.20	42.70	6.13	0.99
environmental damaging-environmental friendly	1.00	0.80	0.80	5.80	7.50	24.10	60.10	6.31	1.12

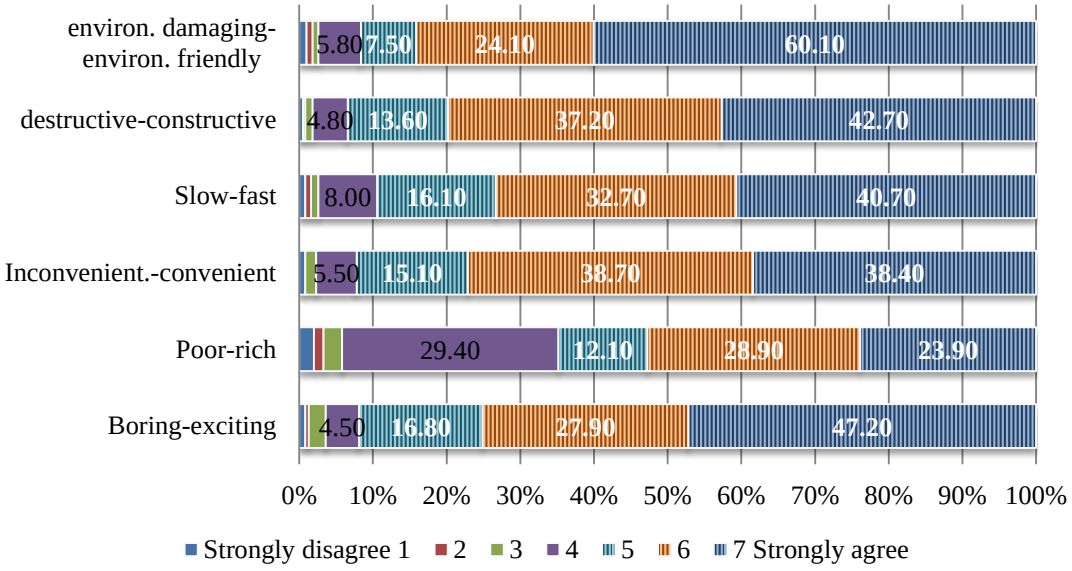


Figure 6-11: Percentages of attitudinal-aspects statements

6.1.6 Summary

This section summarizes the results obtained from the questionnaire survey of the drivers' behavioural intention towards future sky train usage. A sample size of 398 was obtained, comprising 89.9 percent, 3.8 percent, and 6.3 percent of motorcycles, motor-taxis, and other users of modes, respectively. Most respondents are students, who age between 18 to 25 years old. About half of the respondents have no

monthly income, presumably the high school students; 18 percent have monthly income smaller than $100; 20 percent is in range of $101 to $200. Nearly half of the respondents are from the household with more than 5 members. The majority of the respondents have no car in their household but nearly half of the total respondents have at least one motorcycle in their household. Results show that respondents spent approximately 2,000 Riel for their trip. The average trip time is found to be 18.84 minutes and the average trip length is found to be 5.77 Kilometres. It is found that approximately 89 percent of the total respondents have availability to use their vehicle when they want to use; this affect the preference of using the public transportation. Whereas 56.3 percent of the total respondents have no driving license; this showing that among of the motorists currently commute on this study line, some of them are riding without the driving license. In other words, even though they do not have the driving license but they still have the vehicle availability to use. This can be one of reasons of poor use of the public transportation.

The statement of attitudes, subjective norms, perceived behavioural control, behavioural intention, moral obligation, awareness of consequences, and attitudinal aspects toward future sky usage are found to be strongly in agreement. In addition, almost 82 percent of the total respondents stated that they will use the future sky train when the system is available and about 66 percent of them willing to spend about 2,000 Riel. The majority of respondents think that the sky rail system will help alleviating both traffic congestion and pollution issue in Phnom Penh city.

6.2 Modelling Results

6.2.1 Data Structure for Modelling

Three sets of structural equation model are estimated. Such information included respondents' socioeconomic characteristics, trip characteristics, psychological questions towards future sky train usage, and the additional questions of the attitudinal aspects were keyed and input into the database using SPSS. Each piece of information was represented in a numerical form data with different types of measurement (scale, nominal, ordinal) according to its natural value; for instance, the variable gender

would value 1 if it was a male respondent and 0 otherwise. Descriptions of all the variables used in the modelling are shown in Table 6-16.

Table 6-16: Description of variables

No.	Variables	Measure	Value	Description
1	Gender	Dummy	0/1	Gender of respondent (1: male; 0: otherwise)
2	Occupation	Dummy	0/1	respondent ‘s occupation(1:student; 0:otherwise)
3	Income	Scale	integer	Respondents' categorical income
4	Vehicle availability	Scale	integer	Vehicle availability of respondent
5	Driving license	Scale	integer	Respondents' driving license holder
6	Attitudes (AT)	Scale	integer	Respondent's attitude toward future sky train usage
7	Subjective norms (SN)	Scale	integer	Respondent's SN toward future sky train usage
8	Perceived behavioural control (PBC)	Scale	integer	Respondent's PBC toward future sky train usage
9	Moral obligation	Scale	integer	Respondent's MO toward future sky train usage
10	Awareness of consequences WC)	Scale	integer	Respondent's AWC toward future sky train usage
11	Behavioural intention (BI)	Scale	integer	Respondent's BI toward future sky train usage
12	Instrumental aspect of PT	Scale	integer	Respondent's instrumental aspect of future sky train usage
13	Symbolic/ affective aspect of PT	Scale	integer	Respondent's symbolic/affective aspect of future sky train usage
14	Social orderliness aspect of PT	Scale	integer	Respondent's social orderliness aspect of future sky train usage

6.2.2 Reliability of Latent Variables

The homogeneity of the items within the dimensions measuring each psychological latent variables was evaluated by means of the Cronbach’s alpha coefficients. From Table 6-17, it can be seen that those construct variables can be used in the structural equation modelling analysis with the acceptable reliability. It can be observed that the value of Cronbach’s alpha of moral obligation and

symbolic/affective aspect for public transport are a little bit lower than the acceptable limit of Crobach's alpha. We assume these are acceptable for the model analysis since only one statement can be used in the structural equation modelling analysis.

Table 6-17: Summary of homogeneity of latent variables

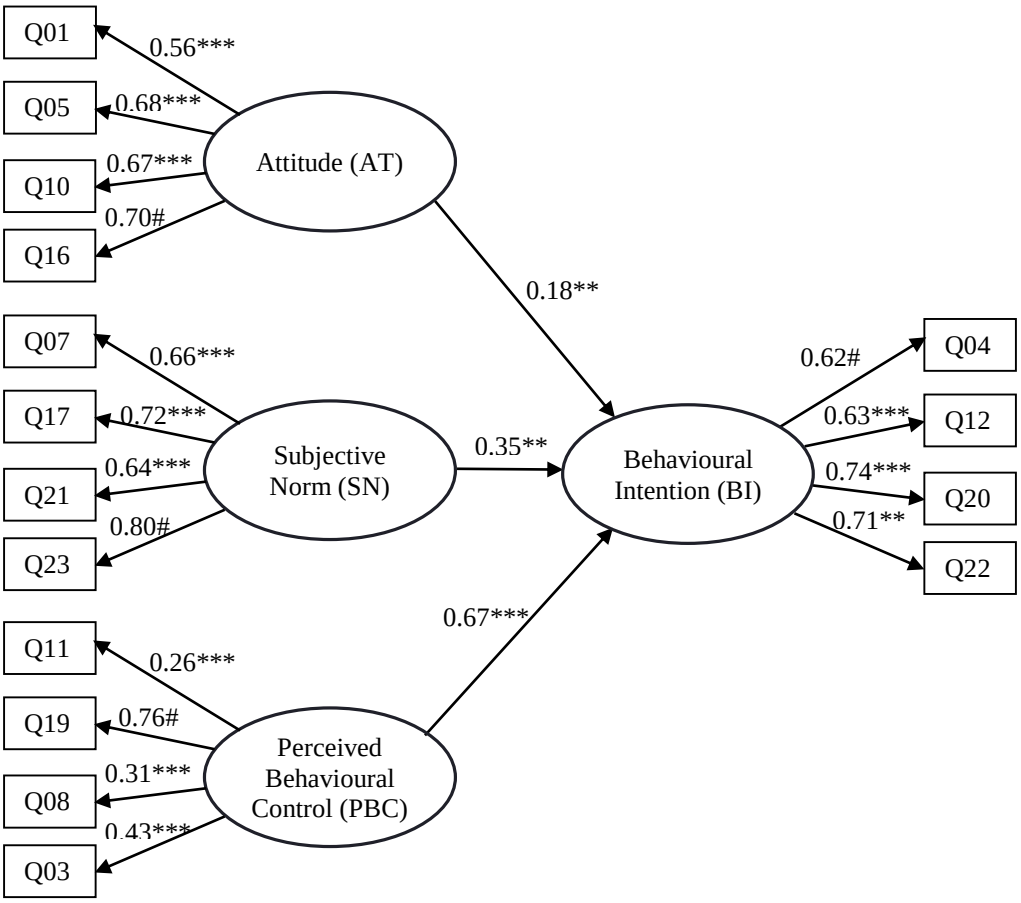
Variables	Number Of Items	Mean	SD.	Cronbach's Alpha (α)
Perceived Behavioural Control (PBC)	4	5.68	0.90	0.63
Moral Obligation (MO)	3	5.97	0.86	0.59
Attitude (AT)	4	6.01	0.80	0.75
Subjective Norm (SN)	4	5.52	1.06	0.80
Awareness of consequence (AWC)	3	6.17	0.79	0.67
Behavioural Intention (BI)	4	5.41	1.11	0.80
Social Orderliness	2	6.22	0.91	0.63
Symbolic/Affective	2	4.45	1.06	0.53
Instrumental aspect	2	6.01	0.95	0.68
Income	1	1.93	1.29	-
Occupation	1	0.41	0.49	-
Gender	1	0.75	0.43	-
Vehicle Availability	1	1.11	0.31	-
Driving License	1	1.56	0.50	-
Willingness to pay	1	-	-	-

6.2.3 Modelling Results

We investigated three set of structural equation models. The models to be tested in the first set (Model I) strictly followed the TPB concept. In the second set of the structural equation model (Model II), we enhance Model I with addition of psychological variables, namely, moral obligation and awareness of consequences. We also introduced additional variables, attitudinal-aspect of future sky train, namely, symbolic/affective aspect for public transport, instrumental aspect for public transport, and social orderliness aspect for public transport. In the last model (Model III), we extended Model II, taking into account additional variables such as gender, occupation, income, vehicle ownership and availability of driving license.

⊙ Model I (Basic Model of TPB)

In the first model, we estimate the commuter's behavioural intention toward future sky train usage based on the basic model of TPB. We hypothesize that respondents' attitude, subjective norm and perceived behavioural control have a positive influence on behavioural intention towards future sky train usage. Figure 6-12 presents the result of structural model with standardized path coefficients. Overall, this model gives a χ^2 value of 360.283 with 88 degrees of freedom. The standardized direct effects on the behavioural intention are 0.18 for attitude, 0.35 for subjective norm and 0.67 for perceived behavioural control. It is found that all TPB core constructs are statistically significant determinants for behavioural intention of using future sky train and perceived behavioural control is found to be a high influencing determinant to the behavioural intention.

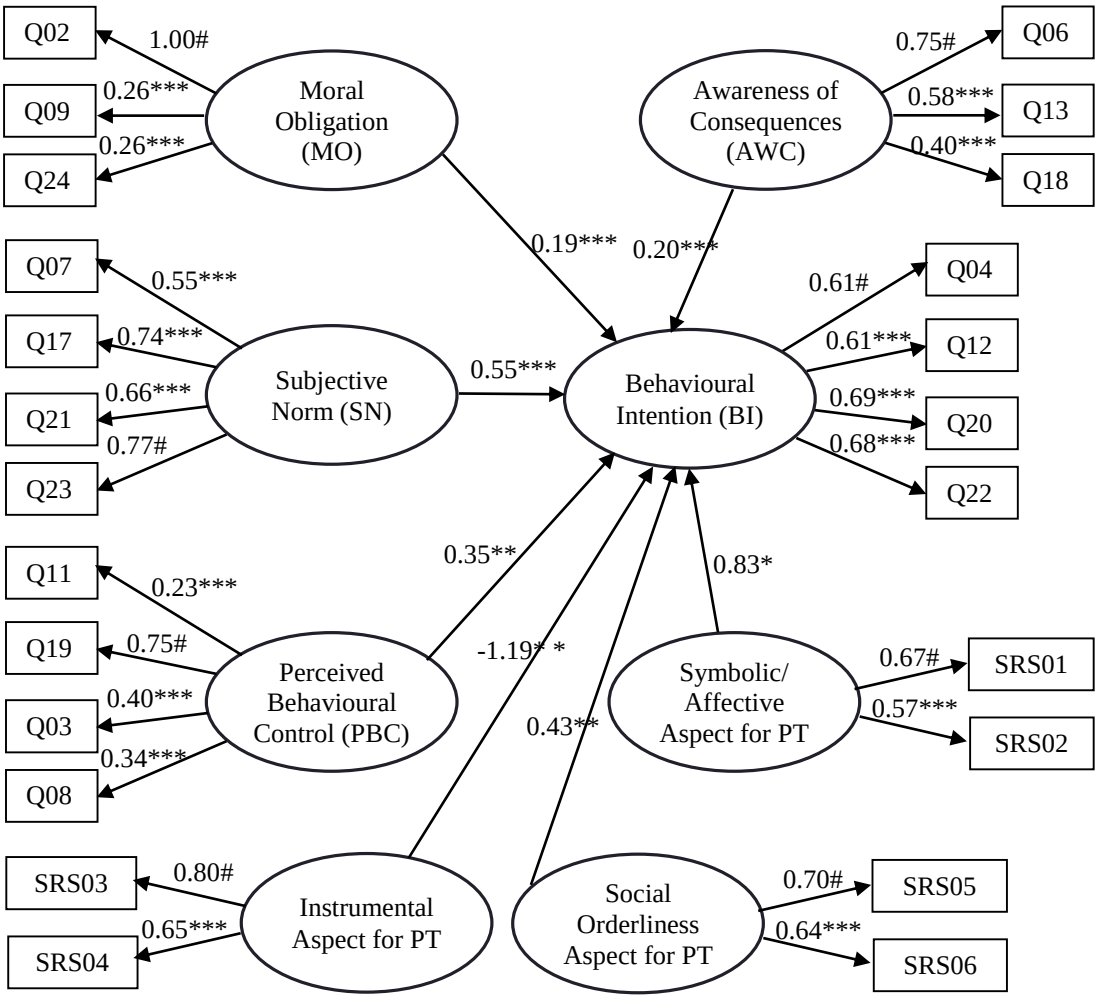


χ^2=360.283, d.f. = 88, NFI = 0.872, CFI = 0.899, RMSEA = 0.088
Note: # Value fixed at 1.00; * p<.05, ** p<.01, *** p<0.001

Figure 6-12: SEM Result for Model I

The goodness of fit statistics indicates that this model fits the data well. Specifically, the RMSEA value of 0.088 is lower than the upper limit of 0.10 and NFI value of 0.872 and CFI value of 0.899 are better in range of the cut-off value of 0 to 1. As hypothesized, attitude, subjective norm and perceived behavioural control is found to have a significantly positive influence on behavioural intention towards future sky train usage. The p-values show that the standardized direct effects of attitude, subjective norm and perceived behavioural control are significantly at 95% of confident level.

⊙ Model II (Enhanced TPB Model)



χ^2=905.150, d.f.= 214, NFI = 0.778, CFI = 0.818, RMSEA = 0.090
Note: # Value fixed at 1.00; * p<.05, ** p<.01, *** p<0.001

Figure 6-13: SEM Result for Model II

In the second model, we enhance the first model by adding the moral obligation and awareness of consequence. Additionally, we replaced the attitude variable by three groups of attitudinal aspects, namely, symbolic/affective, instrumental and social orderliness aspect. We hypothesized that the behavioural intention toward future sky train could be explained by the subjective norm, perceived behavioural control, moral obligation, awareness of consequences, and the three attitudinal aspects on public transport.

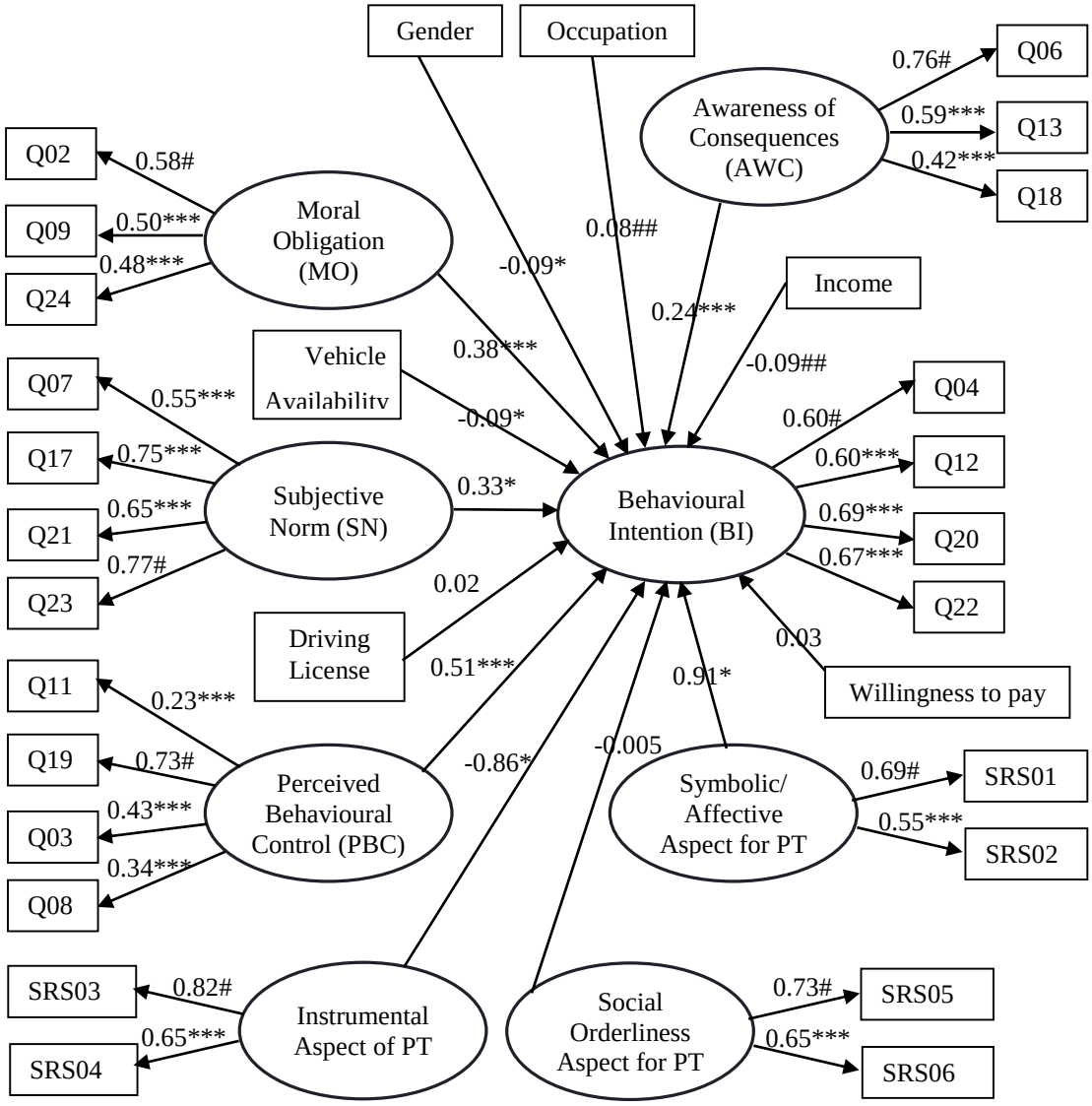
Figure 6-13 presents the model estimation result. We found that moral obligation, awareness of consequences, symbolic/affective and social orderliness attitudinal aspects positively influence the behavioural intention toward future sky train usage. However, the instrumental aspect is found to be statistically significant but negatively influences the behavioural intention. The results depicted in Figure 5-13 have $\chi 2$ value of 905.150 with 214 degrees of freedom, NFI value of 0.778, CFI value of 0.818 and RMSEA value of 0.090. Although the NFI is slightly low and the RSMEA is marginally higher than 0.08, the model fitted the data moderately well. The standardized direct effects on the behavioural intention are 0.55 for subjective norm, 0.35 for perceived behavioural control, 0.19 for moral obligation, 0.20 for awareness of consequence, 083 for symbolic/affective aspect, 0.43 for social orderliness aspect and -1.19 for instrumental aspect. The p-values show that the standardized path coefficients are significant at 95% of confident level.

⊙ Model III (Extension of TPB Model)

In the third model, we extend the second model by adding potential socioeconomic and travel characteristic variables, namely, gender, occupation, driving license and vehicle availability. We hypothesize that these variables may have some effects on the behavioural intention towards future sky train usage, while keeping other variables similar to model II.

From the model estimation results in Figure 6-14, the standardized direct effects on behavioural intention are 0.51 for perceived behavioural control, 0.38 for moral obligation, 0.33 for subjective norm, 0.24 for awareness of consequences, -0.005 for social orderliness aspect, 0.91 for symbolic/affective aspect, -

0.86 for instrumental aspect, -0.09 for income, 0.08 for occupation, -0.09 for gender, -0.09 for vehicle availability, 0.02 for driving license, and 0.03 for willingness to pay.



χ^2=1037.514, d.f.= 355, NFI = 0.771, CFI = 0.834, RMSEA = 0.071
Note: # Value fixed at 1.00; ## p<0.10, * p<.05, ** p<.01, *** p<0.001
Gender is a dummy variable, where 1=male and 0 = female. Similarly, occupation is a dummy variable, where 1 = students and 0 otherwise. The income variable is categorical.

Figure 6-14: SEM Result for Model III

We observed that for socioeconomic variables, respondents' occupation, income and gender are found to significantly influence the behavioural intention. In particular, gender and income are found to significantly influence the behavioural intention in negative sign. Similarly for travel characteristic variables, vehicle availability is found to negatively influence the behavioural intention, while the

estimated coefficient for driving license and willingness to pay are positive but not statistically significant. Overall, this model yields a χ^2 value of 1037.514 with 355 degrees of freedom, NFI value of 0.771; CFI value of 0.834 and RMSEA value of 0.071. It can be observed from the results that the model fitted the data well. Although the NFI, CFI are slightly lower than 0.90, the RMSEA value is in the recommended value.

6.2.4 Model Comparisons

In terms of root mean square error approximation value (RMSEA) and the value of $\chi 2$/df among these three models, it can be seen that model III is a better model to investigate the commuters' behavioural intention towards future sky train usage (see Table 6-18). In this model, the behavioural intention toward future sky train usage can be explained by many variables more than other two models such as attitudinal aspect for sky train usage, subjective norm, perceived behavioural control, moral obligation, and awareness of consequences, socioeconomic characteristics and trip characteristics.

Table 6-18: Model comparisons

Goodness-of-fit Indices	**Model I**	**Model II**	**Model III**
$\chi 2$	360.283	905.150	1037.514
df	88	214	355
χ^2 / df	4.090	4.229	2.922
NFI	0.872	0.778	0.771
CFI	0.899	0.818	0.834
RMSEA	0.088	0.090	0.071

6.3 Discussion

Using empirical data from Phnom Penh commuters, results from structural equation models reveal that the behavioural intention towards future urban rail usage is significantly influenced by attitudes, subjective norm, perceived behavioural control, moral obligation, awareness of consequences,

attitudinal aspect variables, socio economic variable and travel characteristics. The instrumental attitudinal aspect, income, gender, and vehicle availability are found to influence negatively on the behavioural intention in our models. This may be because of the respondents' belief on the speed and convenience of the public transport that is quite low given that they currently experience poor public transport service. Thus, this result prompts transport operators to seriously consider the quality of service of public transport, the issue that has not been taken care much in Phnom Penh. Female respondents are more likely to use sky train, and respondents who own vehicles already or those who have high income are less likely to use the future sky train.

In terms of travel characteristic variables, driving license is not significant in the model. It can be implied that the behavioural intention of using future public transport does not depend on whether the respondents own the driving license.

In terms of willingness to pay variable, the estimated coefficient is found in positive value but the p value is found bigger than 0.10. This means that willingness to pay variable is found insignificant in the model. The behavioural intention towards future sky train usage is pretty much less depend on willingness to way comparing with other variables in the model which are the high determinants of intention to use future sky train.

It can be observed from all three models that the estimated coefficient of each latent variables always change the order of the influence to the behavioural intention. For example in the model I, perceived behavioural control (PBC) is found to be the highest determinant of intention to use future sky train, while in the model II with the additional of moral obligation, awareness of consequences and the new attitudinal aspects variables, the perceived behavioural control is found to be the fourth order of the influence determinants of the behavioural intention. This may be due to the fact that the other variables that we have added into the model I have more influence to the intention than the basic variable of the TPB in model I; for example the symbolic/affective aspect is found to be the highest influent determinant of the behavioural intention of using future sky train.

It should be noted from our finding that the behavioural intention toward future sky train usage is also influenced by the moral obligation and awareness of consequences. Moreover, the determinants of attitudes, which in this case consist of symbolic/affective and instrumental aspects, are also found to be of statistical significance. Consequently, it can be implied that intervention of attitudes would be the most effective way in changing the behavioural intention of using urban public transportation.

It can be implied that the Phnom Penh commuter's behavioural intention towards future sky train usage should consider on attitudes, subjective norm, perceived behavioural control, moral obligation, and awareness of consequences, attitudinal aspect variables, socio economic variable and travel characteristics. The transportation operators should seriously consider the quality of service of public transport, since this issue has not been taken care much in Phnom Penh. In terms of perceived behavioural control, moral obligation and awareness of consequences, transportation planners should provide campaign or advertisement to Phnom Penh road users about the way how to use sky train and its advantages. In terms of attitudinal aspects, the transport planners should also take lesson learnt from others countries which are successful on this area to covey the Phnom Penh road users about urban public transportation to make them more confident on their individual feeling or perception to use public transportation such rail system. In term of driving license and vehicle available, it can be observed that most of the respondents have high availability to use the vehicle, whereas only about 44 percent of the total respondents who have the driving license are found. This may result in the high probability of making traffic accident as JETRO reported that most of the traffic accident is made up of the motorcycles. Due to these issues, transportation operators should take measures to reduce vehicle availability and convince road users to use more public transport.

Chapter 7

Results for Traffic Safety

This chapter summarizes the descriptive statistics of questionnaire survey of drivers' attitudes toward perceived risk of accident, the result of SEM analysis model and discussion. Section 7.1 summarizes the descriptive statistics of sample data which include the socioeconomic characteristics, drivers' attitude toward risky driving behaviour, descriptive of psychological questionnaire. Section 7.2 shows the results of SEM analysis model and section 7.3 overviews the discussions of drivers' attitudes and their perceived risk of traffic accident.

7.1 Descriptive Statistics

7.1.1 Socioeconomic Characteristics

Among the respondents, most of them are male. About 5 percent of the total respondent are less than 18 years old, about 49 percent are in range of 19 to 25 years old, 36 percent from 26 to 40 years old, 9.5 percent 41-65 years old and 0.4 percent from 66 to 80 years old. Approximately 40 percent of the total respondents are students; 4.1 percent are teacher; 10.3 percent are employees; 7.8 percent are civil servants, 12.3 percent are sellers and the rest are unemployed and others (see Table 7-1). About 43 percent of the respondents have no monthly income, presumably the students; about 13 percent have a monthly income smaller than $100; 26 percent is in range of $101-$200 (see Figure 7-1).

Table 7-1: Summary of socioeconomic characteristics

Variables	Levels	Percentage	Variables	Levels	Percentage
Gender	Female	20.6	Education	Primary school	11.6
	Male	79.4		Secondary school	10.8
Age	< 18 years old	5.3		High school	17
	19-25 years old	48.6		Associate bachelor	17.4
	26-40 years old	36.2		Bachelor	34.9
	41-65 years old	9.5		Higher than Bachelor	8.3
	66-80 years old	0.4			
Occupation	Student	39.7	Member in household	< 3	4.1
	Teacher	4.1		3	19.4
	Employee	10.3		4	19.4
	Employer	7.8		5	21.5
	Seller	12.3		6	15.3
	Civil Servant	7.4		7	9.5
	Unemployed	1.2		> 7	10.7
	Others	16.9			

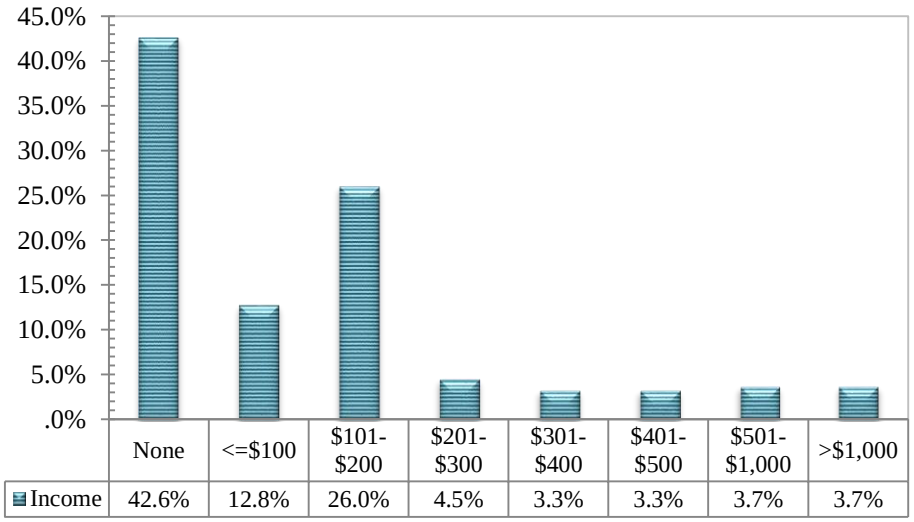


Figure 7-1: Income of respondent

It can be seen from the Figure 7-2 that the majority of respondents have no car in their household which is about 65 percent of the total respondents and nearly 24 percent of them have one car in their household follow by 6.3 percent (2 cars), 1.7 percent (3 cars), 1.7 percent (4 cars) and 0.4 percent (5 cars). About 32 percent of total respondents have at least one motorcycle in their household, 29.8 percent (2

motorcycles), 19.8 percent (3 motorcycles) and others (see Figure 7-2). The percentage of number of vehicle in household is found to be increasing compared with the previous survey.

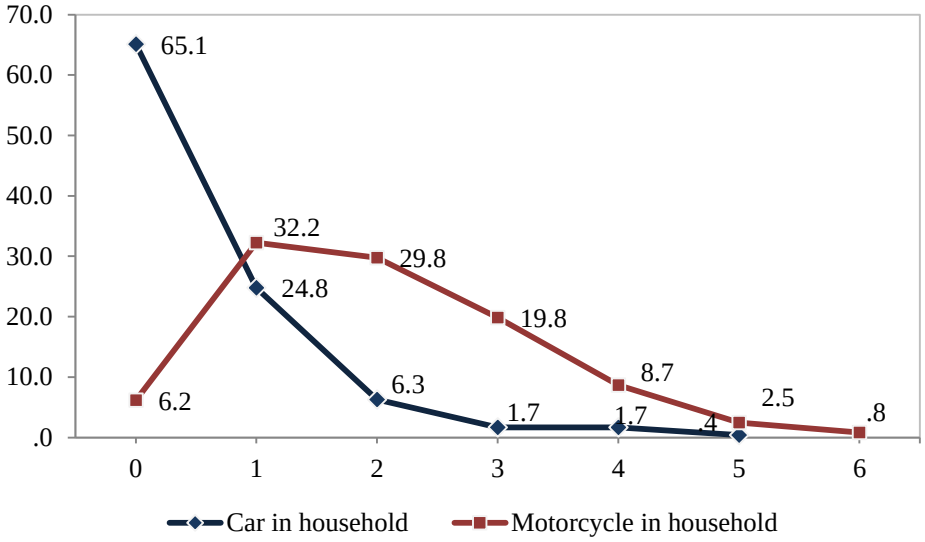


Figure 7-2: Number of vehicle in household

Regarding the driving license, only 42.4 percent of total respondent have driving license and about 57.6 percent of respondents don't have it (see Table 7-2). Most of respondent use motorcycle for their travel mode which is about 79.8 percent of total respondent, motor-taxi (4.5 percent), private car (7 percent), taxi car (0.8 percent) and other modes (7.8 percent).

Table 7-2: Trip characteristics

Variable	Levels	Percentage
Driving license	Have	42.4
	Not have	57.6
Travel mode	Motorcycle	79.8
	Motor-taxi	4.5
	Private car	7
	Taxi car	0.8
	Other	7.8

7.1.2 Drivers' Behaviour

From the Figure 7-3, it can be seen that the majority of total respondents have never pulled over or punished for drunk driving. There is only 9 percent of total respondents who have one time experience of pulling over and punishing for their drunk driving behaviour and 2.3 percent of respondent are experience more than one time. About 68.70 percent of total respondents have never joined the seminar or event talking about drunk driving in their community. Approximately 21 percent are not sure; 5.8 percent used to join one time; 2.90 percent used to participate several times; and 1.60 have joined many times.

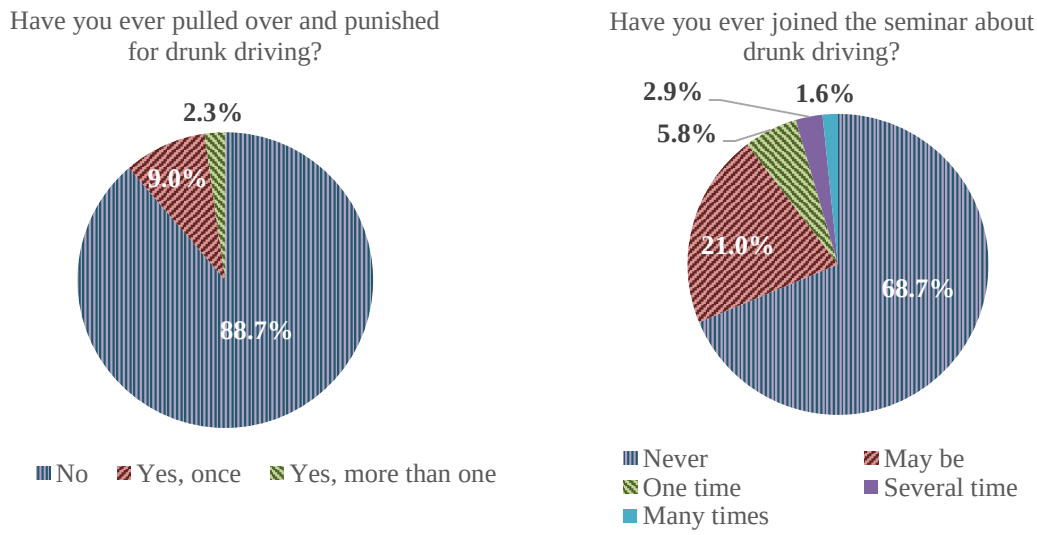


Figure 7-3: Drunk driving behaviour (1)

Figure 7-4 shows the drivers' drunk driving behaviour. About 25 percent of total respondents used to take car at least one time with driver or rider who had drunk alcohol and might be drunk and 18.90 percent of respondents had experienced of taking care with drinking alcohol driver/rider or drunk driver/rider. Approximately, 56 percent of responds had never get into car with drunk driver or riders. This result shows a high percentage of passengers who might have high risk of accident from drinking driving since drivers are drunk drivers or riders. It is found that only 36 percent of total respondents knew the drivers who had been punished for drunk driving and almost 64 percent of respondents had never know anyone who had been punished from their drunk driving.

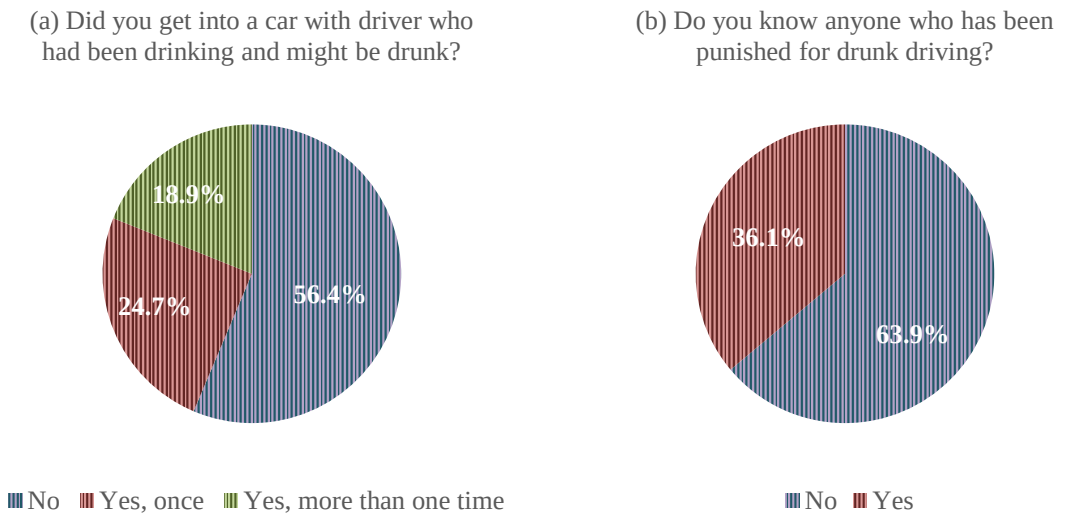


Figure 7-4: Drunk driving behaviour (2)

Figure 7-5 show the drivers' perception regarding distraction driving speeding driving and careless driving behaviour. It is found that about 51.30 percent of total respondent are sometime using phone during driving or riding vehicle, 9.30 percent of respondents often use it and 0.80 percent of respondents use it almost all times when they drive or ride vehicle.

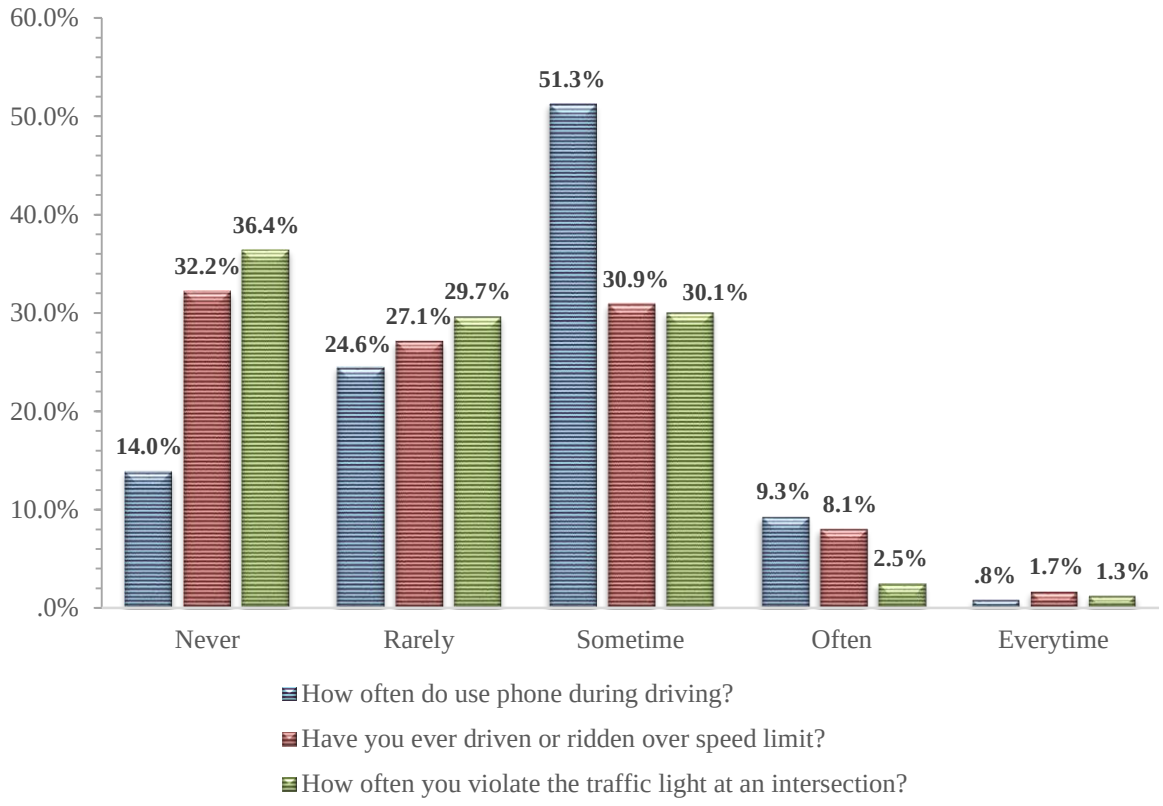


Figure 7-5: Distraction driving, speeding and careless driving behaviour

Whereas about 25 percent of respondents rarely use phone during driving or riding and 14 percent of respondents never use it while they driver or ride vehicle.

Approximately 31 percent of total respondents have sometime driven or ridden vehicle over the speed limit (in urban area: 30 km/h for motorcycle and 40 km/h for car), 8.10 percent of respondent often do it and 1.70 percent of respondents do it every time, 27.10 percent of respondents rarely do it and 32.20 percent of respondents have never do it.

Regarding the violation of traffic light at intersection, about 30 percent of total respondent have ever violated the traffic light at the intersection (i.e. keep going during yellow light or red light) and 36.40 percent answered never violating the traffic light at intersection. Among the total respondents, about 30 percent sometime violating the traffic light, 2.50 percent often violating, 1.30 percent every time violating, 29.70 percent rarely violating and 36.4 percent never violating.

Table 7-3: Have you ever driven or ridden vehicle under these conditions:

Driving conditions	Never	Yes, once	Yes, more than one time
Stress driving	24.30%	35.70%	40%
Fatigue driving	22.50%	30.50%	47%
Arousal driving	42.10%	36.20%	21.70%

From Table 7-3, it is found that most of respondents are experience with driving or riding vehicle under the stress, fatigue and arousal condition. About 24.30 percent of total respondents have never driven or ridden vehicle under stress driving while 35.70 percent and 40 percent of respondents are experience at least one time and more than one times. Similarly, about 22.50 percent of respondents have never experienced with fatigue driving, 30.50 percent used to drive vehicle at least one time under fatigue condition and 47 percent used to experience more than one time. As for arousal driving, about 42.10 percent of respondents has no experience while 36.20 percent and 21.70 percent of total respondent used to drive under the arousal condition once and more than one time. This finding suggests the relevant institutions to consider the suitable countermeasures to solve these issues.

Figure 7-6 shows the drivers' attitudes towards some risky driving behaviours such as drunk driving, driving without wearing helmet or seat-belt, old vehicle driving, high speed driving and driving with phone call. It is found that the majority of respondents think that these driving behaviours are risky and dangerous. By considering on the rate of scoring number 5, it can be seen that 75.30 percent of respondents think that high speed driving is dangerous and may cause traffic accident, following by drunk driving (73.60 percent), driving without wearing helmet or seat-belt (72.30 percent), driving with phone call (54 percent) and old vehicle driving (53.20 percent).

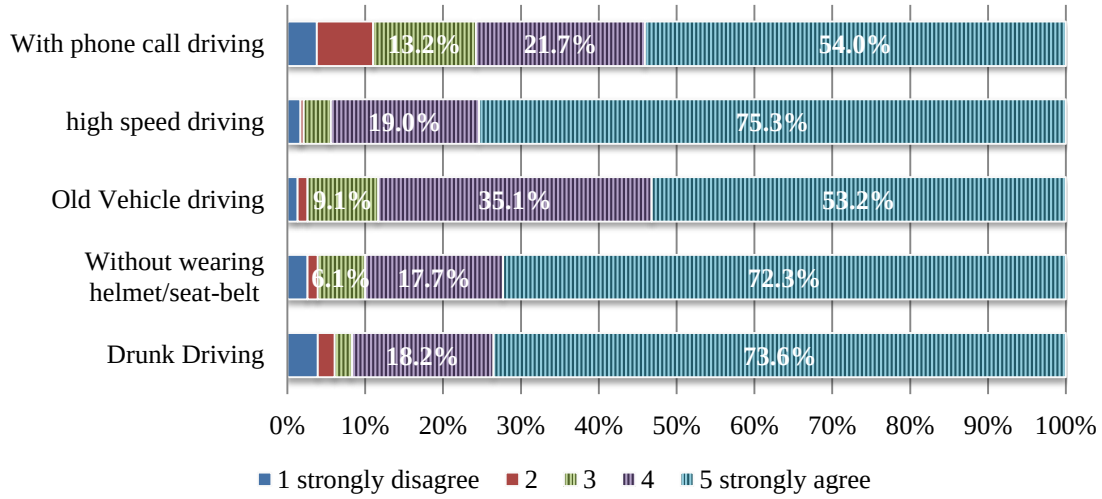


Figure 7-6: Drivers' attitude towards risky driving behaviours

7.1.3 Descriptive of Psychological Questionnaire

Table 7-4 and Figure 7-7 summarize the respondents' response on safety awareness of drinking driving. It shows the percentage of five-point Likert scale, mean and standard deviation value of two statements. It can be seen from the Table 5-22 that about 30 percent of the respondents think that driving vehicle after little drinking of alcohol and driving for short distance after drinking alcohol are ok whereas more than 30 percent of respondents have contrast thinking on this safety issues. More than 15 percent of the respondents are found not sure whether it is fine. It can be denoted that both statements almost have the equal score and standard deviation. In term of mean, it can be conclude that the respondents are confusing themselves whether driving after drinking alcohol is fine or not.

Table 7-4: Percentage, mean and standard deviation of lack of safety awareness

Code	Stat. No.	Strongly disagree → Strongly agree					Mean	Std. Dev.
		1	2	3	4	5		
DDB_15	Q05	20.90	13.40	26.80	18.80	20.10	3.03	1.40
DDB_16	Q06	32.60	19.70	15.90	19.70	12.10	3.00	1.42

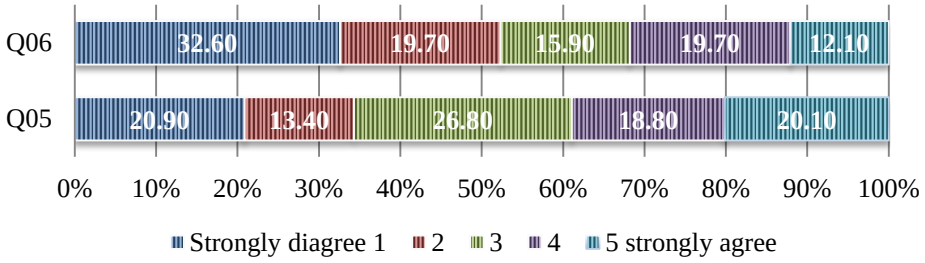


Figure 7-7: Percentage of lack of safety awareness statements

From Figure 7-8, it can be seen that the majority of respondents have strongly agreed that the law of drunk driving should made more severe and the control of drunk driving should be increased more. About 66.70 percent of respondents strongly agree with first statement and 68.10 percent for second statements. The Table 7-5 show the value of mean of first statement 4.49 with the standard deviation of 0.89 and the mean of the second statement is 4.47 with the standard deviation of 0.93. In term of mean, it can be concluded that the respondents strongly agree with both statements. Overall, the respondents think that the lack of law of drunk driving is more concerned.

Table 7-5: Percentage, mean and standard deviation of lack of law awareness

Code	Stat. No.	Strongly disagree → Strongly agree					Mean	Std. Dev.
		1	2	3	4	5		
DDB_19	Q07	2.50	1.70	7.60	20.20	68.10	4.49	0.89
DDB_20	Q08	3.40	1.70	5.90	22.40	66.70	4.47	0.93

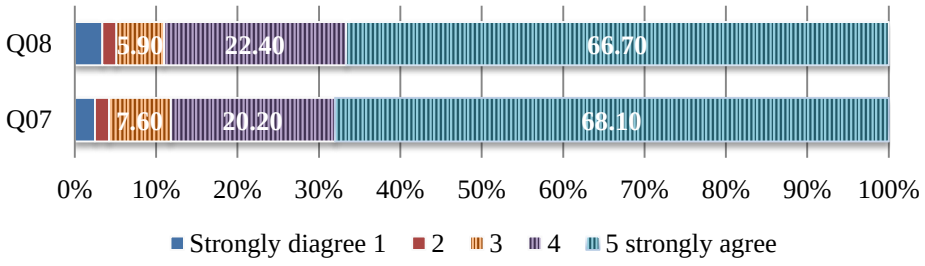


Figure 7-8: Percentage of lack of law awareness statements

Table 7-6 and Figure 7-9 shows the respondents' awareness of drinking driving. It can be seen that most of respondents have agreed with all statements. About 56.4 percent of total respondents strongly agree with the first statement, 51.70 percent for the second statement, 55.50 percent for the third statement and 37. 90 percent for the fourth statement. In term of mean, it can be observed that the respondent strongly agree with the questions. In other words, it can be concluded that the respondents' awareness regarding drinking driving is high. They think that they will not drive vehicle if they drink alcohol or they will not drink alcohol if they are driver. They use or will use the current or future public transport instead.

Table 7-6: Percentage, mean and standard deviation of awareness of drinking driving

Code	Stat. No.	Strongly disagree → Strongly agree					Mean	Std. Dev.
		1	2	3	4	5		
DDB_24	Q12	5.10	5.10	10.60	22.90	56.40	4.20	1.13
DDB_25	Q13	5.50	2.50	10.20	30.10	51.70	4.19	1.08
DDB_26	Q14	6.80	6.40	10.60	20.80	55.50	4.11	1.23
DDB_27	Q15	9.40	12.80	19.60	20.40	37.90	3.65	1.34

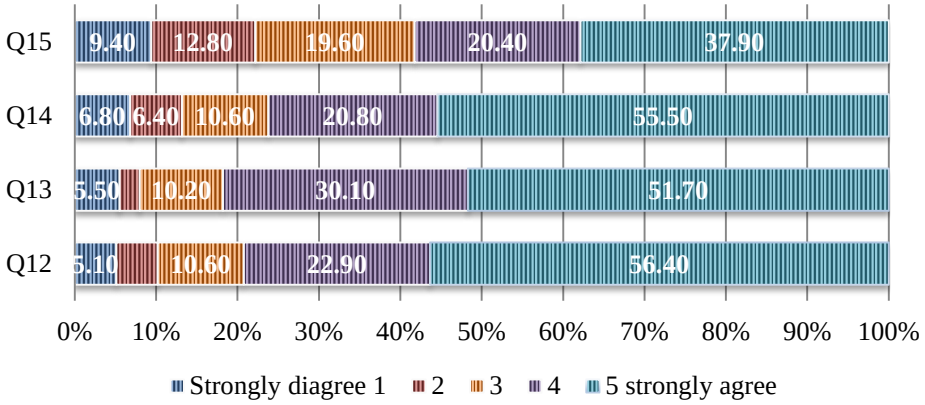


Figure 7-9: Percentage of awareness of drinking driving statements

The distraction driving was measured by asking respondent to rate four statements. Table 7-7 shows the percentage, mean and standard deviation of distraction driving questions. It can be seen that most of respondents agree that distraction driving is bad manner and dangerous. From the Figure 7-10, about 54 percent of total respondents strongly agree with statement mentioned that making or receiving phone call during driving is bad manner and dangerous. Approximately, 49 percent of respondents strongly agree that stress driving is dangerous and may cause the traffic accident. Similarly, about 60.70 percent

of total respondents also strongly agree that fatigue and arousal driving are dangerous and risky. About 71.40 percent of respondent strongly agree that smoking or watching video during driving is risky and dangerous. Overall, it can be concluded that respondents have agreed that distraction driving is risky and dangerous.

Table 7-7: Percentage, mean and standard deviation of distraction driving

Code	Stat. No.	Strongly disagree → Strongly agree					Mean	Std. Dev.
		1	2	3	4	5		
CDB_13	Q16	3.80	7.20	13.20	21.70	54.00	4.15	1.13
CDB_15	Q17	1.70	2.10	16.70	30.30	49.10	4.23	0.92
CDB_16	Q18	1.70	0.90	8.50	28.20	60.70	4.45	0.82
CDB_22	Q19	2.10	3.40	3.40	19.70	71.40	4.54	0.88

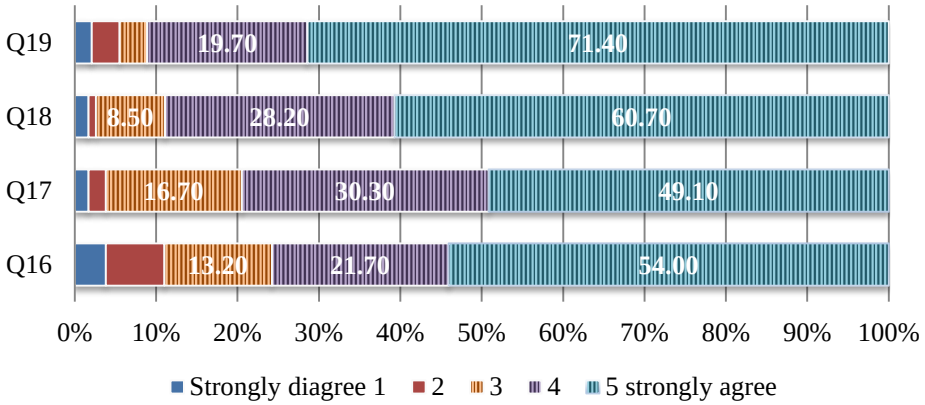


Figure 7-10: Percentage of awareness of distraction driving statements

Regarding the awareness of distraction driving, respondents were asked to rate two statements. More than 50 percent of total respondents strongly agree with the statements. The first stamen has the value of mean 4.34 with standard deviation 0.91 and the mean of second statement 4 with standard deviation 1.04 (see Table 7-8). About 51.70 percent strongly agree that they should not pick up or make phone call during driving and about 56.40 percent strongly agree not to drive in the condition of arousal, stress and fatigue (see Figure 7-11). These findings mean that the respondents' awareness regarding distraction driving are high.

Table 7-8: Percentage, mean and standard deviation of awareness of distraction driving

Code	Stat. No.	Strongly disagree → Strongly agree					Mean	Std. Dev.
		1	2	3	4	5		
CDB_20	Q20	5.10	5.10	10.60	22.90	56.40	4.34	0.91
CDB_21	Q21	5.50	2.50	10.20	30.10	51.70	4.00	1.04

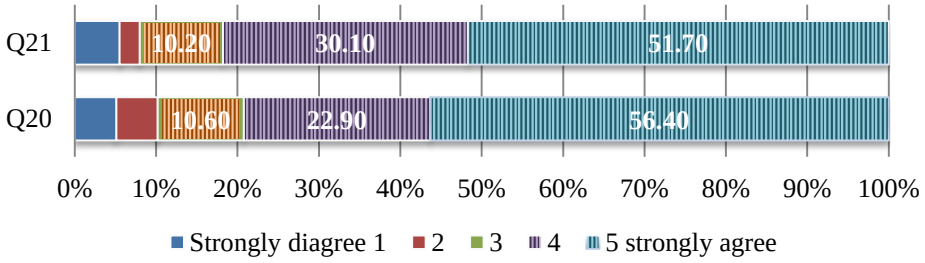


Figure 7-11: Percentage of awareness of distraction driving statements

The perceive risk of traffic accident was measured by asking respondents to answer four statements. The majority of respondents have strongly agree with those statements (see Table 7-9 and Figure 7-12). The first statement asked respondents about their thinking regarding over taking and high speed driving. It is found that 75.50 percent of total respondents have strongly agreed that over taking and high speeding driving is dangerous and may cause the traffic accident. The second statement asked respondents about their drinking driving. About 73.30 percent of total respondents have strongly agreed that it risky and dangerous if driving under the influence of alcohol. Whereas, the third statement asked respondents to give the rate about careless driving: driving without wearing helmet or seat-belt. It is observed that about 72.30 percent of respondents have strongly agree with this statement: driving without wearing helmet or seat-belt is risky and dangerous. The last statement asked respondents about driving with uncheck vehicle or old vehicle. About 53.40 percent of respondents have strongly agreed about the danger and riskiness of accident because of this driving behaviour.

Table 7-9: Percentage, mean and standard deviation of perceived risk of traffic accident

Code	Stat. No.	Strongly disagree → Strongly agree					Mean	Std. Dev.
		1	2	3	4	5		
CDB_19	Q22	1.70	0.40	3.40	18.90	75.50	4.66	0.73
DDB_23	Q25	3.80	2.50	2.10	18.20	73.30	4.55	0.95
CDB_14	Q24	3.00	1.30	6.00	17.40	72.30	4.55	0.89
CDB_17	Q23	1.30	1.30	9.00	35.00	53.40	4.38	0.80

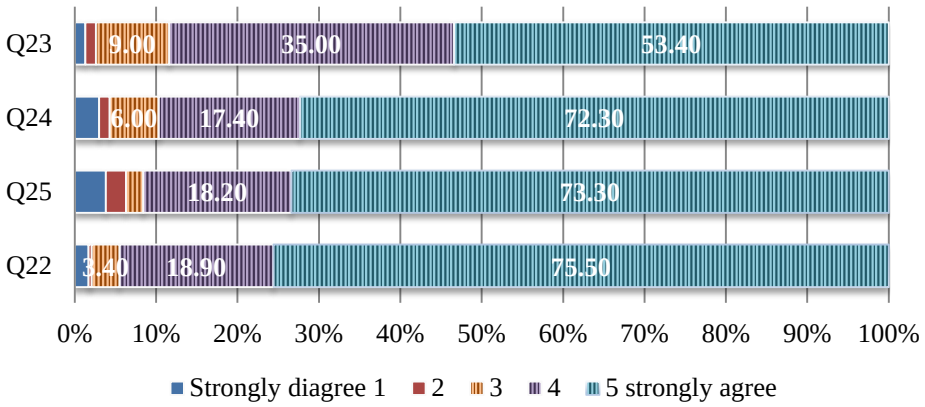


Figure 7-12: Percentage of perceived risk of traffic accident statements

7.1.4 Summary

This section summarizes the descriptive results of questionnaire survey of the drivers' attitude toward perceived risk of traffic accident. A sample size of 243 was collected, comprising 39.70 percent of student, 4.10 percent of teacher, 10.30 percent of employee, 7.80 percent of employer, 12.30 percent of seller, 7.40 percent of civil servant, 1.20 percent of unemployed people and 16.90 percent of others. Most of respondents are holding bachelor degree which about 34.90 percent, following by 17.40 percent of associate bachelor degree and 8.30 percent of higher than bachelor degree. About 43 percent of the respondents have no monthly income, presumably the students; about 13 percent have a monthly income smaller than $100; 26 percent is in range of $101-$200. Most of respondents have one or two motorcycle and nearly 24 percent of respondents have one car in their households. About 58 percent of total respondents do not have driving license.

The majority of respondents have never pulled or punished from drunk driving and have never joined the seminar or the program talking about drunk driving. Approximately 31 percent of respondents have sometime driven vehicle over the speed limit and about 30 percent of respondent have sometime violated the traffic light at the intersection by keeping going during yellow or red light and about 36.40 percent answered never violating the traffic light at intersection. Almost 52 percent of total respondent sometime make or received phone call during driving.

Most of respondents are experience with driving or riding vehicle under the stress, fatigue and arousal conditions. The majority of respondents think that some risky driving behaviours such as drinking driving, high speed driving, driving with old vehicle, driving without wearing helmet or seat-belt and driving with phone call are risky and dangerous.

The statement of perceived risk of traffic accident, distraction driving, lack of safety awareness, lack of law, awareness of drinking driving, awareness of distraction driving and others are found to be strongly in agreement. The detail structure analysis will be shown in the next section.

7.2 Modelling Result

7.2.1 Data Structure for Modelling

The relationship between various drivers' attitudes to risky driving behaviours such as speeding driving, drunk driving, careless driving, distraction driving and other risky driving behaviour and perceived risk of traffic accident will be analysed. The data were keyed and input into the database using SPSS and MS. Excel. Each piece of information was represented in a numerical form data with different types of measurement (scale, nominal, ordinal) according to its natural value; for instance, the variable gender would value 1 if it was a male respondent and 0 otherwise. Descriptions of all the variables used in the modelling are shown in Table 7-10.

Table 7-10: Description of variables

No.	Variables	Measure	Value	Description
1	Drinking frequency	Scale	Integer	Respondents' drinking frequency
2	Drinking level	Scale	Integer	Respondents' drinking level
3	Lack of knowledge about drunk driving	Scale	Integer	Respondents' attitude to lack of knowledge about drunk driving
4	Lack of law awareness	Scale	Integer	Respondents' awareness about drunk driving law
5	Lack of safety awareness	Scale	Integer	Respondents' awareness about drunk driving safety
6	Lack of skill awareness	Scale	Integer	Respondents' awareness about driving skill
7	Awareness of drinking driving	Scale	Integer	Respondents' awareness about drinking driving
8	Risk of drunk driving	Scale	Integer	Respondents' attitude toward drunk driving
9	Distraction driving	Scale	Integer	Respondents' attitude toward distraction driving

No.	Variables	Measure	Value	Description
10	Awareness of distraction driving	Scale	Integer	Respondents' awareness about distraction driving
11	Lack of punishment awareness	Scale	Integer	Respondents' awareness about lack of punishment
12	Perceived risk of traffic accident	Scale	Integer	Respondents' self-reported perception about risk of traffic accident

7.2.2 Reliability of Latent Variables

The reliability of the latent psychological variables were evaluated by means of the Cronbach's alpha coefficients. From Table 7-11, it can be seen that those latent variables can be used in the structural equation modelling analysis with the acceptable reliability. It can be observed that the value of Cronbach's alpha of lack of safety awareness are a little bit lower than the acceptable limit of Crobach's alpha. We assume these are acceptable for the model analysis since only one statement can be used in the structural equation modelling analysis.

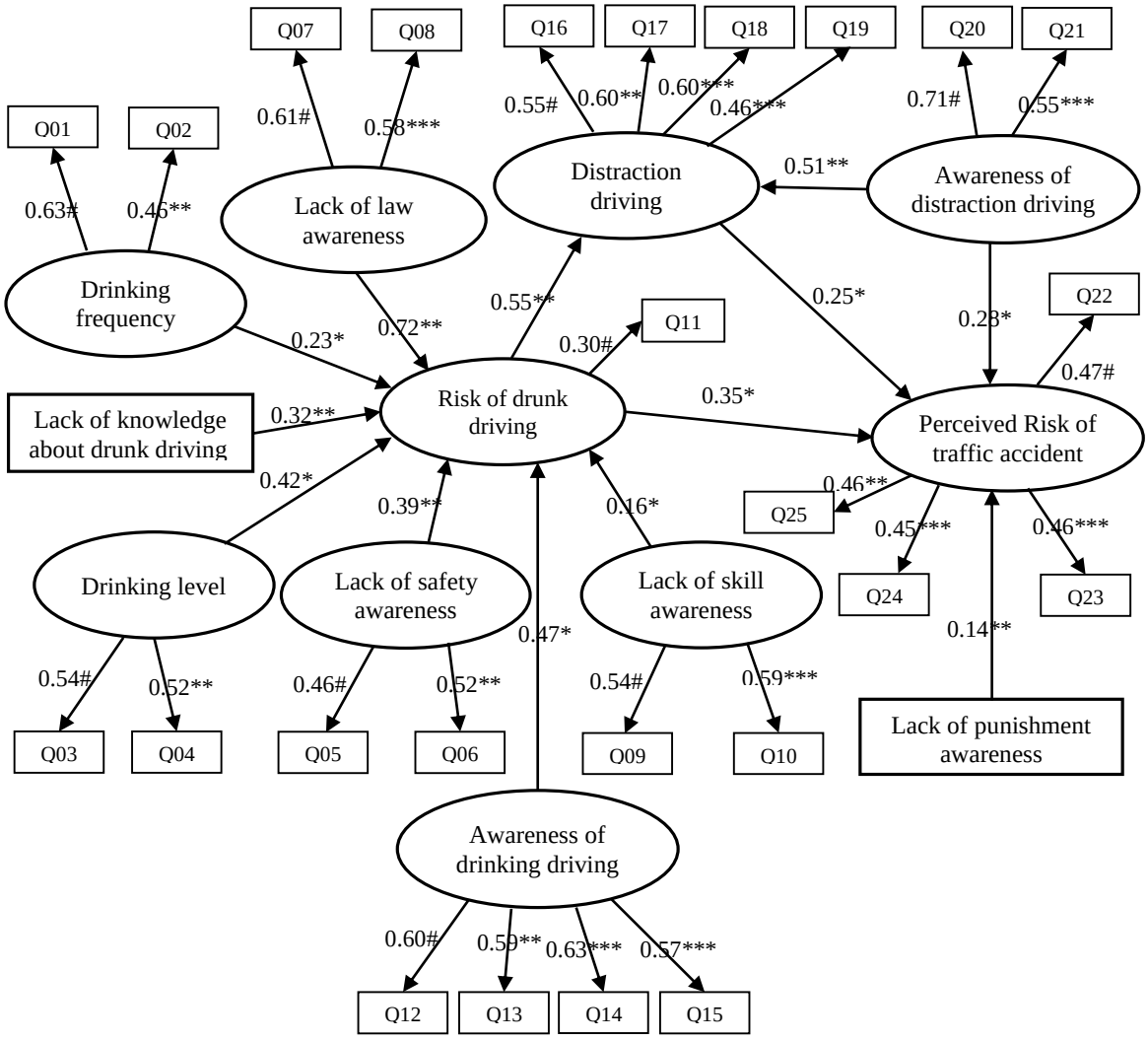
Table 7-11: Summary of reliability of latent variables

Variables	Number Of Items	Mean	SD.	Cronbach's Alpha (α)
Drinking frequency	2	1.92	0.81	0.66
Drinking level	2	1.75	0.65	0.64
Lack of law awareness	2	4.49	0.78	0.68
Lack of safety awareness	2	2.82	1.16	0.59
Awareness of drinking driving	4	4.03	0.85	0.67
Distraction driving	4	4.35	0.73	0.78
Awareness of distraction driving	2	4.17	0.83	0.61
Risk of drunk driving	1	4.44	1.14	-
Perceived risk of traffic accident	4	4.53	0.61	0.71

7.2.3 Modelling Result

The relationship between various drivers' attitudes to risky driving behaviours such as speeding driving, drunk driving, careless driving, distraction driving and other risky driving behaviour and perceived risk of traffic accident will be analysed. As for risk of drunk driving, we hypothesized that lack of skill

awareness, lack of law awareness, lack of safety awareness, awareness of drinking driving, drinking frequency, drinking level and lack of knowledge about drunk driving will have influence on the risk of drunk driving. Whereas, the risk of drunk driving, distraction driving, awareness of distraction driving, lack of punishment are hypothesized to have influence on perceived risk of accident.



χ^2=616.216, d.f. = 286, GFI=0.710 NFI = 0.733, CFI = 0.838, RMSEA = 0.066
Note: # Value fixed at 1.00; * p<.05, ** p<.01, *** p<0.001

Figure 7-13: Structural analysis model of perceived risk of traffic accident

Figure 7-13 shows the result of the structural analysis model of perceived risk of traffic accident with the standardized path coefficients. Overall, this model gives χ2 value of 616.216 and 286 degree of freedom. The standardized direct effects on perceived risk of accident are 0.35 for risk of drunk driving,

0.25 for distraction driving, 0.14 for lack of punishment awareness and 0.25 for awareness of distraction driving. Lack of law awareness, lack of safety awareness, lack of education/media advertising about danger of drunk driving, lack of skill awareness, drivers' attitude to drinking level and drinking frequency and awareness of drunk driving of drive are found to have standardized direct effect on risk of drunk driving of 0.72, 0.39, 0.32, 0.16, 0.42, 0.23, and 0.47 respectively.

The goodness-of-fit statistics indicate that this model fits the data appropriately. Specifically, the RMSEA value of 0.066 is lower than the upper limit of 0.10 and NFI value of 0.733, CFI value of 0.838 and GFI value of 0.710 are better in range of the cut-off value of 0 to 1. As hypothesized, lack of skill awareness, lack of law awareness, drinking frequency, drinking level, lack of safety awareness and lack of education/media advertising about danger of drunk driving have positive influence on the risk of drunk driving. The risk of drunk driving, distraction driving, and lack of punishment awareness are also found significantly influence on perceived risk of traffic accident. While, the awareness of drunk driving and awareness of distraction driving are also found to have positive standardized coefficients.

7.3 Discussion

From the descriptive results, most of drivers had never been pulled over or punished from drunk driving, never joined the seminar about drunk driving and often used phone or done other distraction activities during driving motorcycle or car. This finding will be useful for traffic polices or relevant institutions take measures, hold seminar or educational program on television or radio or campaign about danger or result of some risky driving behaviours such drunk driving, distraction driving, high speeding driving, careless driving and others to road users in Phnom Penh.

It is also found that most of drivers are willing to use public transport if they drink alcohol; this finding is quite positive for transportation operator and relevant institutions to start thinking of running the public transportation mode in city as soon as possible to reduce traffic accident and traffic congestion in city. The results show that most of drivers used to have experience at least one time of fatigue or stress or arousal driving, this finding prompt the transportation engineers or planners to start thinking of

applying suitable measures or operating the public transportation mode to reduce the individual driving in order to reduce traffic accident and also the congestion.

From the structural model result, it is found that the drivers who are lack of law awareness have the highest risk of drunk driving following by lack of knowledge or media broadcasting about danger of drunk driving and others. This result suggests the government or relevant institutions to seriously consider of increasing the drivers' awareness regarding the traffic law by reinforcing, revising the traffic law and make it much more severe and promoting the media systems to broadcast the measures, traffic rules, reports or news about crashes or fatality of drunk driving. Drivers' attitude towards drinking level and drink frequency are also found to have high influence on risk of drunk driving.

The result shows that drivers who have lack of safety awareness also take high risk to drunk driving. These results prompt traffic polices or relevant officers to consider the educational and safety measure of drunk driving to Phnom Penh road users. In addition, the relevant institutions can convey the information, knowledge, safety measure or the accident of the drunk driving via the campaign or TV program and radio program. Doing so could make road users more understand and also increase their knowledge and safety awareness of drunk driving. Beside the improvement of road facilities, considering on enforcement and educational measure of drivers and their awareness are very important. In case of awareness of drinking driving, we have asked the respondent to think of using public transport instead of driving or riding vehicle or not to drive or ride vehicle when they drink alcohol. It is found to have positive influence to risk of drunk driving. This may be due to the fact that, the awareness and action of drivers are different; in other words, the driver's awareness is high but they still drive after drinking alcohol or it could be because of the poor service and inappropriate public transportation systems in city. In this case, the quality of the service of public transport should also be considered in order to change drivers' attitude. The result also shows that lack of skill awareness has influence on risk of drunk driving. This can be implied that whether drivers have high or low skill of driving awareness, the risk of drunk driving is still highly occurred. The drivers who have high skill of driving awareness may have high risk of drunk driving.

Risk of drunk driving, distraction driving, lack of punishment awareness and awareness of distraction driving are found to be significantly influent on perceived risk of accident. Risk of drunk driving has the highest influence comparing with distraction driving, lack of punishment awareness and awareness of distraction driving. In other words, drivers with high alcohol consumption are found to have higher risk to traffic accident than drivers with careless or distraction driving. Regarding the result of lack of punishment awareness, the government or relevant intuitions should make the severe punishment and more strict to road users.

Chapter 8

Conclusion and Recommendations

This chapter describes the conclusion and recommendations of this research. Section 8.1 provides the overall conclusion of present work in this dissertation. Section 8.2 presents the author's perspectives on the contributions of this research to transportation behaviour, to Cambodia and to other ASEAN countries. Section 8.3 suggests the recommendations and discusses further extensions and directions for future research in this area.

8.1 Overall Conclusions

This research addresses the latent psychological factors that influence road users' transportation behaviour such as commuters' behavioural intention, their perception of future urban rail transport, drivers' perceived risk of traffic accident and their attitudes towards various risky driving behaviour such as drunk driving, distraction driving, speeding driving, careless driving and other forms of risky driving. The advanced modification and extension of theory of planned behaviour (TPB) to investigate road users' behavioural intention and the investigation on numerical analysis problems in structural equation modelling, the numerical stability in SEM and proposed procedure to be considered when applying SEM (see Figure 4-7 and Figure 4-15) are revealed. The questionnaire surveys have been done three times: pilot questionnaire survey, main questionnaire surveys for behavioural intention towards future urban rail transport and drivers' attitudes towards risky driving behaviours.

As for the commuters' behavioural intention towards future urban rail usage in the city, which currently lacks a formal public transport mode. A pilot survey was conducted as a preliminary study on the feasibility of the application of the theory of planned behaviour (TPB). Afterwards, a main survey was further conducted to collect the information on respondents' socioeconomic and travel characteristics, psychological characteristics, and their attitudinal aspects towards future urban rail transport. Based on a total of 398 respondents, the data obtained from the survey was input into a database and was analysed using both descriptive statistics and structural equation models in order to discover road users' behavioural intention towards future urban rail transport usage. And 231 respondents are useable for the analyses of drivers' attitudes toward perceived risk of accident and risky driving behaviours.

The study shows that the strategies to induce road users to use more public transportation such as a future urban rail transport should be focused at some psychological factors such as attitudes, subjective norm, perceived behavioural control, moral obligation, awareness of consequences, and some socioeconomic and travel characteristics information. Female respondents are more likely to use future urban rail, and respondents who own vehicles already or those who have high income are less likely to use the future urban rail. Almost 95 percent of the total respondents stated that they will use the future urban rail when the system is available, and about 66 percent of them willing to spend about 2,000 Riel. This finding is quite positive for transport operators since more customers in several market segments can be attracted, giving that a good quality service is provided. In terms of travel characteristic variables, the behavioural intention of using future public transport does not depend on whether the respondents own the driving license. It should be noted from our finding that the behavioural intention toward future urban rail usage can be investigated by the theory of planned behaviour (TPB) and its extension. The behavioural intention toward future urban rail usage is also influenced by the moral obligation and awareness of consequences. Increasing the level of moral obligation and awareness of consequences may be reasonable to reduce the private vehicle usage in the future. Moreover, the determinants of attitudes, which in this case consist of symbolic/affective, instrumental and social orderliness attitudinal aspects, are also found to be of statistical significance. Consequently, it can be implied that intervention of attitudes would be the most effective way in changing the behavioural intention of using urban public transportation.

As for the drivers' attitude towards perceived risk of traffic accident, it can be concluded that lack of law awareness, lack of knowledge about drinking driving, drinking level, lack of safety awareness, lack of skill awareness are the main factors to be considered in order to reduce the riskiness of drunk driving behaviour. The perceived risk of traffic accident is statistically influenced from drivers' perception and their attitudes to risky driving behaviour such as drunk driving, distraction driving, careless driving and their awareness. Lack of law awareness are found to be the highest factor of riskiness of drunk driving. This finding can prove that the increasing of the drivers' awareness and knowledge about drinking driving can be one of strategies to reduce traffic accident from drunk driving behaviour. As for lack of skill awareness, it can be implied that whether drivers have high or low skill of driving awareness, the risk of drunk driving is still highly occurred. The driver who have high skill of driving awareness may have high risk of drunk driving. Risk of drunk driving has the highest influence on perceived risk of traffic accident comparing to distraction driving, lack of punishment awareness and awareness of distraction driving. In other words, drivers with high alcohol consumption are found to have higher risk of traffic accident than drivers with careless or distraction driving.

In conclusion, the present study demonstrates the latent psychological factors which should be aimed at in order to change road users' transportation behaviour. To the author's knowledge, this study is the early study regarding the latent psychological factors that could affect the transportation behaviour for Cambodians' drivers.

8.2 Research Contributions

The proposed structural models of latent psychological factors of theory of planned behaviour (TPB) and the proposed attitudinal-aspect for future urban rail transit in this study represent a significant advanced modification and extension of TPB theory and results are also helpful to suggest the countermeasures and develop some strategies for road users in term of psychological aspects.

- Developed methodology to analyse the psychological aspects in transportation problems in developing countries based on TPB and SEM.

- Extended of theory of planned behaviour (TPB) by to determine the commuter's behavioural intention towards future urban rail usage, i.e. moral obligation (MO) and awareness of consequence (AWC), socioeconomic and trip characteristic variables.

- Introduced the attitudinal aspects of public transport, i.e. attitudinal beliefs on symbolic, instrumental and social orderliness aspects into structural model in order to predict the behavioural intention of using future urban rail transit.

- Identified the psychological factors of drivers' perception toward risky driving behaviours.

- Proposed numerical procedure for the reliability and stability result in structural equation modelling (SEM).

- Can be applied to other ASEAN countries.

- Suggest some countermeasures and strategies base on the results of structural models as follow:

The strategies to induce road users to use public transport such as urban rail should be aimed to the latent psychological factors including attitudes, subjective norm, perceived behavioural control, moral obligation, awareness of consequences, attitudinal aspects variable, socioeconomic variable and travel characteristics. The results show that by changing these latent psychological factors of the commuters, the behavioural intention towards future urban rail transport usage will also be changed. Therefore, the government or relevant institutions should also consider on these latent psychological factors in order to success. The results from the structural models suggest the transport operators or planners should be more concern about the quality service, comfort, convenience of public transport since the users are currently experience with the poor public transport service and these issues have not been taken care. In term of subjective norm, transportation planner or investors should consider the effects of relatives or important person of commuters since this group of people also have influence on the commuters' decision to use future urban rail transit. In term of travel characteristic variable, the behavioural intention

of using future public transport does not depend on whether the respondents own the driving license. In term of perceived behavioural control, moral obligation and awareness of consequences, transportation planners should provide campaign or advertisement to road users to know about urban rail system and its advantage. The actual behavioural intention towards future urban rail usage is yet to be investigated. Contribution of the results from the present study is hoped to shed some light on future urban rail in terms of travel demand. In addition, the analysis results can be additionally used for future research and study on transportation planning in order to induce the commuters to use more public transportation.

Moreover, the results from structural models of drivers' attitude also can suggests some strategies to reduce traffic accident in Cambodia. The increasing the drivers' attitudes, awareness and other psychological factors may be reasonable to reduce the traffic accident and violation. For example; in term of lack of law awareness, the government or relevant institutions should seriously consider of reinforcing, revising the traffic law and making it much more severe, broadcasting the countermeasures, traffic rules and others information about crashes or fatality of drinking driving in order to increase drivers' awareness and also to reduce the riskiness of traffic accident. As for lack of safety awareness, traffic polices or relevant officers should consider the educational and safety countermeasures of drunk driving to road users by broadcasting through the campaign, TV program or radio program. Doing so could make road users more understand and also increase their knowledge and safety awareness of drinking driving. Beside the improvement of road facilities, considering on enforcement and educational measure of drivers and their awareness are very important.

8.3 Recommendations and Further Research

In this dissertation, we developed methodology to analyse the psychological aspects of transportation behaviour in developing countries based on the theory of planned behaviour (TPB) and structural equation modelling (SEM). The government or relevant institutions should also consider the psychological aspects into transportation planning, demand and safety due to the results of this study. As for the behavioural intention towards future urban rail transport, it is recommended that Municipality of Phnom Penh should initiate the urban rail system project based on the outputs of this study in terms

of potential travel demand and should focus on these psychological factors to induce the road users to use public transport. Transportation operators or investors should consider the effect of the group of people who have influence commuters and also the quality of service of public transport in order to attract more users to use public transport. Since the study investigates the commuters, motorists, further research is needed for other road users such as tourists. Different users with different socioeconomic characteristics would have different behavioural intention towards future urban rail.

As for traffic safety, the government or relevant institutions should seriously consider of reinforcing, revising the traffic law and making it much more severe. Also traffic police or relevant officers should consider the enforcement, educational or safety countermeasures and awareness of drivers. Increasing the drivers' attitudes, their awareness and other latent psychological factors can be reasonable to reduce the riskiness of traffic accident.

Although the outcomes of the models are good to investigate the commuters' behavioural intention toward future urban rail usage and drivers' attitude toward perceived risk of traffic accident, the study can be improved by including more variables such as past behaviour, private vehicle usage, frequency of mode usage and other psychological variables might improve the explanatory power of behavioural intention to use future urban rail and perception of riskiness of traffic accident. Paying more attention on the respondent's answer and a clear explanation to the respondents are required before asking them to give the answer.

Bibliographies

[1] Central Intelligence Agency (CIA). *EAST & SOUTHEAST ASIA: CAB*ODIA. <https://www.cia.gov/library/publications/the-world-factbook/geos/cb.html>. Accessed: April 14, 2014.

[2] National Road Safety Committee. *Annual Report, Cambodia*. 2012

[3] Cambodia Road Crash and Victim Information System. *Annual Report, Cambodia*. 2010

[4] Neth S., Hirobata Y., Lim I. Identification of transportation improvement projects in Phnom Penh considering traffic congestion level. *Proceeding of the Eastern Asia Society for Transportation Studies*, vol. 5, 1256-1280, 2005.

[5] Japan International Cooperation Agency (JICA). *First steering committee meeting on the project for comprehensive urban transport plan in Phnom Penh Capital City*. 2012 <http://www.jica.go.jp/cambodia/english/office/topics/120426.html> Accessed: April 28, 2014

[6] Japan International Cooperation Agency (JICA). *The study on the transport master plan of the Phnom Penh metropolitan area in the Kingdom of Cambodia*. JICA and Katahira & Engineers International, final report, 2001.

[7] PTIPP. *The project for traffic improvement in Phnom Penh city*. Municipality of Phnom Penh and JICA, Newsletters, vol.1, 2009.

[8] Japanese External Trade Organization (JETRO). *Study on Phnom Penh city sky rail airport line project*. Municipality of Phnom Penh (MPP) and Katahira & Engineers International. Workshop and Summary, 2008 and 2009.

[9] SYSTRA. *FASEP study phase1: Diagnosis and perspective*. Executive Summary. Edition1, 2012

[10] Ajzen I. The theory of planned behaviour. *Organizational Behavioural and Human Decision Process*, 50, 179-211, 1991.

[11] Yang C., and Hsiao, C.H. Predicting the travel intention to take high speed rail among college students. *Transportation Research part F*, 13, 277-287, 2010.

[12] Lam T., and Hsu H.C. Predicting behavioural intention of choosing a travel destination. *Tourism Management*, 589-599, 2006.

[13] Norman P., and Evans D. Understanding pedestrians' road crossing decision: an application of the theory of planned behaviour. *Health Education Research*, vol. 13, No. 4, 481-489, 1998.

[14] Abrahamse W., Steg L., Gifford R. and Vlek Ch. Factors influencing car use for commuting and the intention to reduce it: a question of self-interest of morality. *Transportation Research Part F*, 12, 317-324, 2009.

[15] Choocharukul K., and Satoshi F. Psychological factors influencing behaviour intention of private car use in future work trips. *Journal of the Eastern Asia Society for Transportation Studies*, Vol. 7, 211-222, 2007.

[16] Fujii S., and Van H.T. Psychological determinants of behaviour intention to use travel mode in Ho Chi Minh City. *Journal of Public Transportation*, Vol. 12, No. 1, 97-110, 2009.

[17] Forward E. The theory of planned behaviour: the role of descriptive norms and past behaviour in the prediction of drivers' intentions to violate. *Transportation Research Part F*, 12, 198-207, 2009.

[18] Letirand F., and Delhomme P. Speed behaviour as a choice between observing and exceeding the speed limit. *Transportation Research part F*, 8, 481-492, 2005.

[19] Warner H., and Aberg L. Drivers' decision to speed: a study inspired by the theory of planned behaviour. *Transportation Research part F*, 9, 427-433, 2006.

[20] Paris H., and Brouke S.V. Measuring cognitive determinants of speeding: an application of the theory of planned behaviour. *Transportation Research part F*, 11, 168-180, 2008.

[21] Zhou R., Horrey W., and Yu R. The effect of conformity tendency on pedestrians' road-crossing intentions in China: an application of the theory of planned behaviour. *Accident Analysis and Prevention*, 41, 491-497, 2009.

[22] National Transportation Safety Board (NTSB). *Eliminate substance-impaired driving*. 2013 most wanted list page. <http://www.ntsb.gov/safety/mwl9_2012.html > Accessed: July 30, 2012.

[23] Mirzaei R., Hafezi N.N., Sabag M.S., Moghaddan A.A., Eslami V., Rakhshani F. and Rahimi M.V. Dominant role of drivers' attitude in prevention of road traffic crashes: a study on knowledge, attitude, and practice of driver in Iran. *Accident Analysis & Prevention*, 66, 36-42, 2014.

[24] Sophia T., and George Y. Investigation the self-reported behaviour of drivers and their attitudes to traffic violations. *Safety Research*, 46, 1-11, 2013.

[25] Iversen H. Risk-taking attitudes and risky driving behaviour. *Transportation Research part F*, 7, 135-150, 2004.

[26] Simsekglu O., and Lajunen T. Social psychology of seat belt use: a comparison of theory of planned behaviour and health belief model. *Transportation Research part F*, 11, 181-191, 2008.

[27] Zhou R., Wu Ch., Rau P.L.P., and Zhang W. Young driving learners' intention to use a handheld or hands-free mobile phone when driving. *Transportation Research part F*, 12, 208-217, 2009.

[28] Goeger J.A., and Rothengatter J.A. Traffic psychology and behaviour. *Transportation Research part F*, 1, 1-9, 1998.

[29] Golob T.F. Structural equation modelling for travel behaviour research. *Transport Research part B*, 13, 1-25, 2003.

[30] Norstrom T. Drunken driving: a tentative causal model. *Schandinavian Studied in Criminology*, vol. 6, 197.

[31] Berrer D.E., and Snortum J.R. Drinking-driving compliance in the United States: perceptions and behaviour in 1983 and 1986. *Study Alcohol*, 50 (4), 306-319, 1983-1986.

[32] Ullegerge P., and Rundmo T. Personality, attitude and risk perception as predictors of risky driving behaviour among young drivers. *Safety Science*, 41, 427-443, 2003.

[33] Chen C.F. Personality, safety attitudes and risky driving behaviour-evidence from young Taiwanese motorcyclists. *Accident Analysis & Prevention*, 41 (5), 963-968, 2009.

[34] Machin M.A., and Sankey K.S. Relationship between young drivers' personality characteristics, risk perceptions and driving behaviour. *Accident Analysis & Prevention*, 40(2), 541-547, 2008.

[35] Ajzen I., and Fishbein M. *Belief, attitude, intention and behaviour: introduction to theory and research*. Addison-Wesley, 1971.

[36] Ajzen I., and Fishbein M. *Understanding attitudes and predicting social behaviour*. Englewood Clifffs, NJ: Prentice-Hall, 1980.

[37] Eagly A.H., and Chaiken S. *The psychology of attitudes*. Fort Worth, TX: Harcourt, Brace & Janovich, 1993.

[38] Jillian J.F., Martin F.E., Marie J., Anne W., Jeremy G., Robbie F., Eileen F.S.K., Liz S., and Debbei B. Constructing questionnaires based on the theory of planned behaviour. Center for Health Service Research. United Kingdom, 2004.

[39] Chang M.K. Predicting unethical behaviour: a comparison of the theory of reasoned action and the theory of planned behaviour. *Journal of Business Ethics*, 17, 1825-1834, 1998.

[40] Ajzen I., and Madden T.J. Prediction of goal-directed behaviour: attitudes, intentions, and perceived behavioural control. *Journal of Experimental Social Psychology*, 22, 453-474, 1986.

[41] Schreiber J.B. Core reporting practices in structural equation modelling. *Research in Social and Administrative Pharmacy*, 4, 83-97, 2008.

[42] Kline R.B. *Principle and practice of structural equation modelling*. New York: The Guilford Press, 1998.

[43] Arbukle J.L. *SPSS Amos 19 users' guide*. Amos Development Corporation, 2011.

[44] Bentler P.M. *EQS structural equations program manual*. Multivariate Software, CA, 1995.

[45] Joreskog K.G., and Sorbon D. *LISREL 8 user's guide; PRELIS 2 user's reference guide*. Scientific Software International, Chicago, 1993.

[46] Byrne B.M. Structural equation modelling with AMOS, EQS, and LISREL: comparative approach to testing for the factorial validity of a measuring instrument. *International Journal of Testing*, 1(1), 55-86, 2001.

[47] Nachtigall C., Kroehme U., Funke F., and Steyer R. Why should we use SEM? Pros and Cons of structural equation modelling. *Methods of Psychological Research Online*, vol. 8 (2), 1-22, 2003.

[48] Lei P.W., and Wu Q. *Introduction to structural equation modelling: issues and practical considerations*. Instructional Topics in Educational Measurement (ITEMS), 2007.

[49] Toyoda H. *Covariance structure analysis: structural equation modelling (introductory)*. Asakura Printing, Japan, 1998.

[50] Kojima T. *Covariance structure analysis: a graphical modelling learning with Excel*. Ohmsha Printing, Japan, 2003.

[51] Meguro T., Long B., and Nakatsuji T. Some numerical analysis on structural equation modelling. *Proceeding of Infrastructure Planning*, vol. 44, 2012.

[52] Toyoda H. *Covariance structure analysis: structural equation modelling*. Asakura Printing, Japan, 2003.

[53] Long B., Meguro T., Choocharukul K., Kishi K., and Nakatsuji T. Stability on numerical analysis in structural equation modelling. *Journal of Eastern Asia Society for Transportation Studies*, vol. 10, 660-675, 2013.

[54] Michalewicz Z. *Genetic algorithms + data structures= evolution programs*. Springer, London, 1992.

[55] Tanaka J.S. How big is big enough? Sample size and goodness of fit in structural equation modelling with latent variables. *Child Development*, 58, 134-146, 1987.

[56] Browne P.M., and Cudeck R. Alternative ways of assessing model fit. *Sociological Methods and Research*, 21, 230-258, 1992.

[57] MacCallum R.C., Browne M.W., and Sugawara H.M. Power analysis and determination of sample size for covariance structure modelling. *Psychological Methods*, 1, 130-149, 1996.

[58] Byrne B.M. *Structural equation modelling with AMOS: Basic concepts, applications, and programing*. 2nd Edition. New York: Routledge, Talyor & Fracis Group, 2009.

[59] Bentler P.M. Comparative fit indexes in structural models. *Psychometrika*, 107, 238-246, 1990.

[60] McDonald R.P., and Marsh H.W. Choosing a multivariate model: Non-centrality and goodness-of-fit. *Psychological Bulletin*, 107, 247-255, 1990.

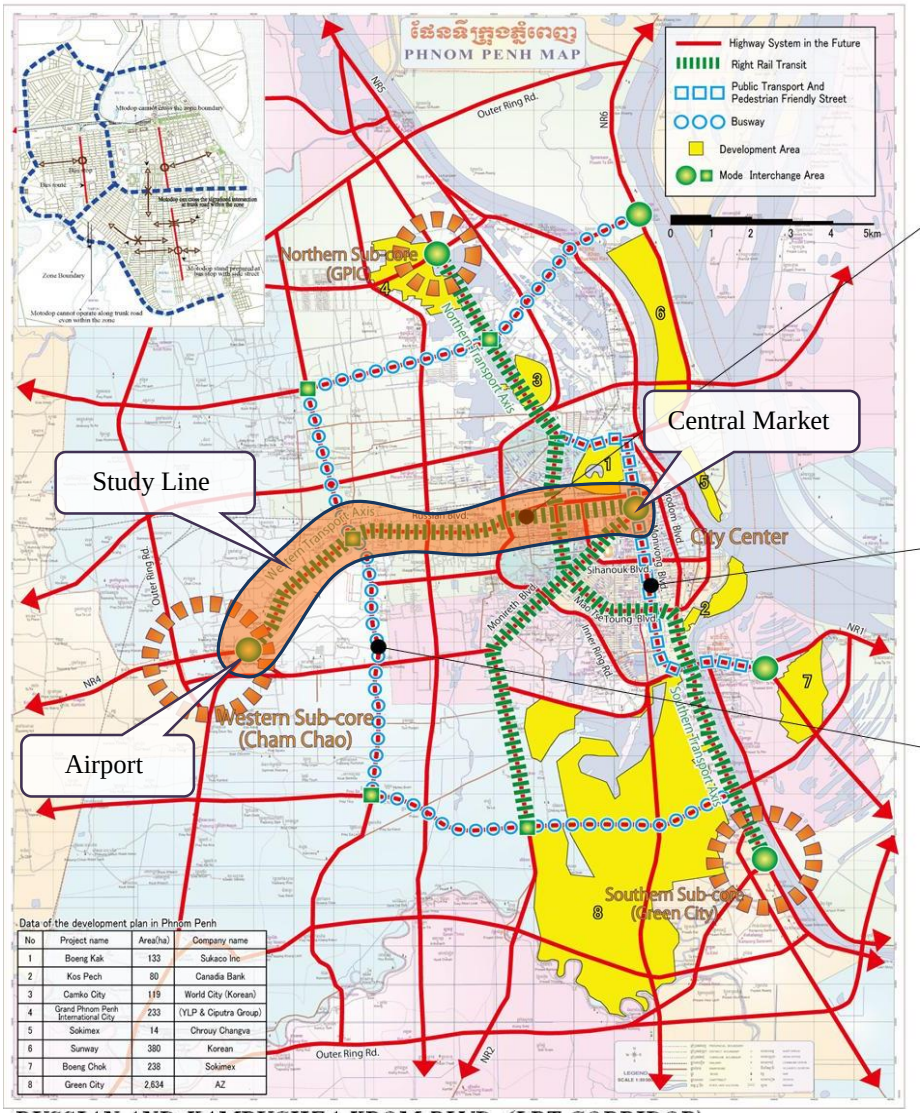
[61] Field A. *Discovery statistics using SPSS*. GB: SAGE Publications, London, 2005.

[62] Word Health Organization (WHO). *Global status report on road safety*. 2010.

Appendix A: Pilot Questionnaire Survey

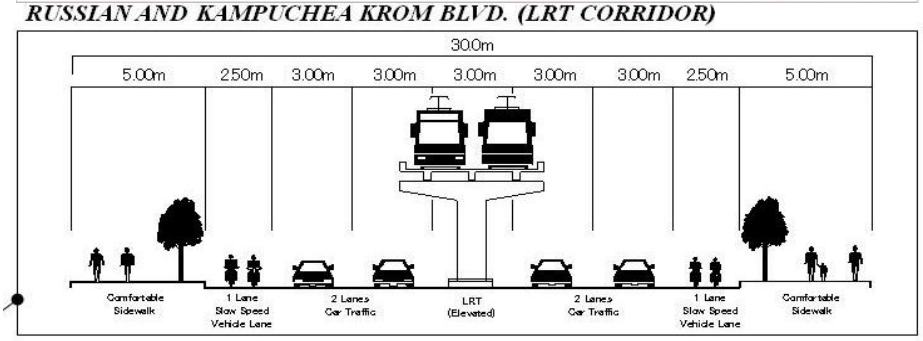
Suppose there is a rail transit system running in Phnom Penh with 3 lines (see the map). Our research study will choose one of these lines, Airport line linking from City center (Central Market) to the western sub-core (Cham Chao). It's about 8.5 km long elevated along Russian and Kampuchea Krom Boulevard (as shown below). We will refer this rail transit system in the survey as future urban rail transit. We would like to ask you some questions for better understanding your future behavioural intention.

FUTUER PUBLIC TRANSPORT SYSTEM IN PHNOM PENH CITY



No	Project name	Area(ha)	Company name
1	Boeng Kak	133	Sukaco Inc
2	Kos Pech	80	Canadia Bank
3	Camko City	119	World City (Korean)
4	Grand Phnom Penh International City	233	(YLP & Ciputra Group)
5	Sokimex	14	Chrouy Changva
6	Sunway	380	Korean
7	Boeng Chok	238	Sokimex
8	Green City	2,634	AZ

RUSSIAN AND KAMPUCHEA KROM BLVD. (LRT CORRIDOR)



Interviewer: _____Location: _____

Survey date: _____Survey time: _____

Study of Urban Rail Transit in Phnom Penh City

Please take a few minutes to answer these questions. There will be 2 sections in this survey. Section 1 will ask about the demographic and socioeconomic information. Section 2 measures the predictor variables and intentions.

Section I:

Age: _____ Gender: ❑ Female ❑ Male

Occupation: ❑ Student ❑ Teacher ❑ Employer ❑ Employee
❑ Seller ❑ Civil servant ❑ Unemployed
Other, please specify: _____

Monthly income: ❑ <$100 ❑ $101-$200 ❑ $201-$300 ❑ $301-$400
❑ $401-$500 ❑ $500-$1,000 ❑ $1,000-$2,000 ❑ >$2,000

Members in household (including yourself): _____

Number of vehicles in household: Car/Pick-up_____Motorbike_____

When you travel along this corridor, what is the typical transportation mode that you use the most? ❑ Motorbike ❑ Motor-taxi other, please specify: _____

When you travel along this corridor, what is the typical trip purpose?
❑ Study ❑ Work ❑ Business ❑ Shopping

From: _____To: _____

Time: _____Travel time: _____Cost: _____

In which District/Commune have you lived? District: _____Commune: _____

Section II:

Please mark (√) the answer for the following questions:

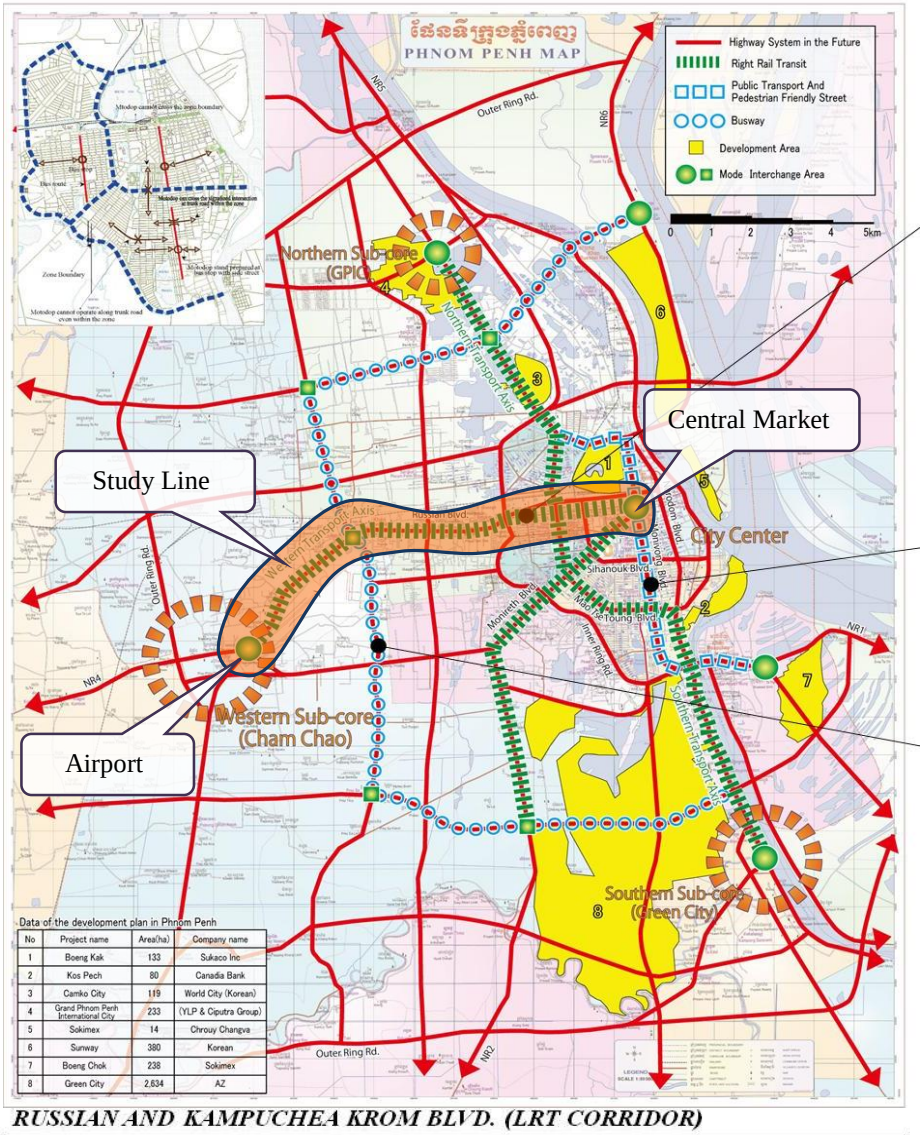
Questions	Strongly Disagree ⟹ Strongly Agree						
	1	2	3	4	5	6	7
1. I prefer using the future urban rail transit.							
2. I have good feeling towards using future urban rail transit.							
3. Using future urban rail transit is desirable to me.							
4. Using future urban rail transit is beneficial to me.							
5. Using future urban rail transit is the right thing to do.							

Questions	Strongly Disagree → Strongly Agree						
	1	2	3	4	5	6	7
6. My friends or my family want me to take future urban rail transit.							
7. If I took the urban rail transit, my friends or my family would have no problem with it.							
8. My friends or my family would agree with using the future urban rail transit.							
9. My friends or my family think that I should use future urban rail transit.							
10. Most of my friends will use future urban rail transit.							
11. I feel under social pressure to use future urban rail transit.							
12. It is easy for me to use urban rail transit.							
13. I am confident that I can use future urban rail transit.							
14. Whether I use the future urban rail transit is completely up to me.							
15. The decision to use future urban rail transit is under my control.							
16. I could use future urban rail transit if I want to.							
17. In term of morality, I think that using future urban rail transit is not problematic.							
18. I should use urban rail transit.							
19. In regard to my decision, I will use future urban rail transit.							
20. I want to use future urban rail transit.							
21. I plan to use future urban rail transit.							
22. I will make an effort to use future urban rail transit.							
23. If I take future urban rail transit, I will arrive at the destination faster.							
24. Using future urban rail transit is depending on the travel distance.							
25. Using future urban rail transit is depending on the travel cost.							
26. Using future urban rail transit is depending on the level of traffic congestion.							
27. Using future urban rail transit will reduce the traffic congestion.							
28. Using future urban rail transit will reduce traffic accidents.							
29. I think that future urban rail transit is safe.							
30. I feel that the air pollution is getting worse.							

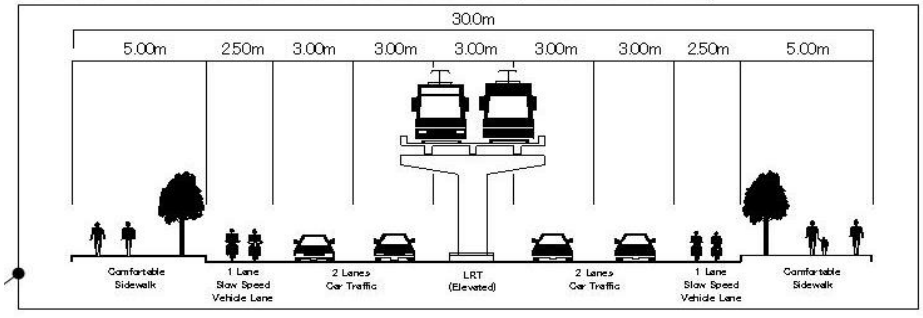
Thank You for Your Participation

ឧទាហរណ៍ថា មានខ្សែរថភ្លើងក្រុង រត់នៅក្នុងទីក្រុងភ្នំពេញ ចំនួន៣ខ្សែ ដូចក្នុងរូបភាពខាងក្រោម។ ១ខ្សែក្នុងចំនោម ខ្សែទាំង៣ គឺខ្សែដែលតភ្ជាប់ពី ផ្សារធំថ្មី ទៅអាកាសយានដ្ឋានអន្តរជាតិពោធិ៍ចិនតុង (ចោមចៅ) ត្រូវបានយកមកសិក្សា។ ខ្សែរថភ្លើងនេះ មានប្រវែងប្រមាណ៨.៥គីឡូម៉ែត្រ ដែលសង់នៅពីលើតាមបណ្តោយ មហាវិថីសហព័ន្ធរុស្ស៊ី និង មហាវិថីកម្ពុជាក្រោម ដូចបង្ហាញ ក្នុងរូបភាពខាងក្រោម។ យើងសន្មតថាខ្សែរថភ្លើងនេះ ជាខ្សែរថភ្លើងក្រុងនៅថ្ងៃខាងមុខ។ ដូច្នេះ យើងត្រូវការស្វង់មតិរបស់លោកអ្នកដើម្បីស្វែងយល់ពីគោលបំណងនៃការប្រើប្រាស់ខ្សែរថភ្លើងក្រុងនៅថ្ងៃខាងមុខ។

FUTUER PUBLIC TRANSPORT SYSTEM IN PHNOM PENH CITY



RUSSIAN AND KAMPUCHEA KROM BLVD. (LRT CORRIDOR)



អ្នកសំភាស: _____ ទីកន្លែង: _____

កាលបរិច្ឆេទ: _____ ម៉ោង: _____

ការសិក្សាខ្សែរថភ្លើងក្រុងនៅក្នុងទីក្រុងភ្នំពេញ

សូមមេត្តាផ្តល់ពេលវេលាពី ពីរ ទៅ បីនាទី ដើម្បីឆ្លើយសំនួរ និង បំពេញនូវពត៌មានមួយចំនួនដូចខាងក្រោម។ នៅក្នុងសំនួរនៃការស្ទង់មតិនេះ ចែកចេញជាពីរផ្នែកសំខាន់ៗ។ ផ្នែកទី១ នឹងសុំអោយលោកអ្នក បំពេញនូវពត៌មានដែលទាក់ទងទៅនឹងពត៌មានអំពីខ្លួនអ្នកផ្ទាល់។ ផ្នែកទី២ នឹងសុំអោយលោកអ្នក ឆ្លើយនូវសំនួរដែលទាក់ទងនឹងគោលបំណងនៃការចង់ប្រើប្រាស់មធ្យោបាយធ្វើដំណើរដោយរថភ្លើងក្រុងនៅថ្ងៃអនាគត។

ផ្នែកទី១:

អាយុ: _____ ភេទ: ❑ ស្រី ❑ ប្រុស

មុខរបរ: ❑ សិស្ស ❑ គ្រូបង្រៀន ❑ និយោជក ❑ និយោជិត
❑ អ្នកលក់ដូរ ❑ មន្ត្រីរាជការ ❑ មិនមានការងារ
ផ្សេងៗចូរបញ្ជាក់: _____

បៀវត្សប្រចាំខែ: ❑ <$100 ❑ $101-$200 ❑ $201-$300 ❑ $301-$400
❑ $401-$500 ❑ $500-$1,000 ❑ $1,000-$2,000 ❑ >$2,000

ចំនួនសមាជិកនៅក្នុងគ្រួសារ (រួមទាំងខ្លួនអ្នក): _____

ចំនួនរថយន្តនៅក្នុងផ្ទះ: រថយន្តតូច/រថយន្ត១បាំងកន្លះ _____ ម៉ូតូ _____

ជាញឹកញាប់ តើអ្នកប្រើប្រាស់មធ្យោបាយអ្វី ពេលដែលលោកអ្នកធ្វើដំនើរតាមមហាវិថីនេះ?
❑ ម៉ូតូ ❑ ម៉ូតូដុប ផ្សេងៗចូរបញ្ជាក់: _____

តើអ្នកធ្វើដំនើរតាមមហាវិថីនេះក្នុងគោលបំណងអ្វី?
❑ សិក្សា ❑ ការងារ ❑ មុខជំនួញ ❑ ទិញឥវ៉ាន់
ចាកពី: _____ ទៅកាន់: _____ ពេលធ្វើដំនើរ: _____
រយៈពេលធ្វើដំនើរ: _____ តំលៃធ្វើដំនើរ: _____

តើសព្វថ្ងៃ អ្នកស្នាក់នៅក្នុងខណ្ឌ/សង្កាត់ណា? ខណ្ឌ: _____ សង្កាត់: _____

ផ្នែកទី២:

ចូរគូសសញ្ញា(√) ដើម្បីឆ្លើយនឹងសំនួរខាងក្រោម:

សំនួរ	មិនយល់ស្រប ⟹ យល់ស្រប						
	1	2	3	4	5	6	7
1. ខ្ញុំ ចង់ធ្វើដំណើរដោយរថភ្លើងក្រុងជាងមធ្យោបាយធ្វើដំណើរឯទៀត							
2. ខ្ញុំ រីករាយនឹង ប្រើប្រាស់រថភ្លើងក្រុងនៅថ្ងៃខាងមុខ							
3. ការធ្វើដំណើរដោយរថភ្លើងក្រុងនៅថ្ងៃខាងមុខគឺជាបំណងប្រាថ្នារបស់ខ្ញុំ							
4. ការធ្វើដំណើរដោយរថភ្លើងក្រុង មានផលល្អច្រើនសំរាប់ខ្ញុំ							
5. ការប្រើប្រាស់រថភ្លើងក្រុង គឺជាជំរើសល្អសំរាប់ការធ្វើដំណើរ							
6. មិត្តខ្ញុំ រីគ្រួសារខ្ញុំ ចង់អោយខ្ញុំ ធ្វើដំណើរដោយរថភ្លើងក្រុង							

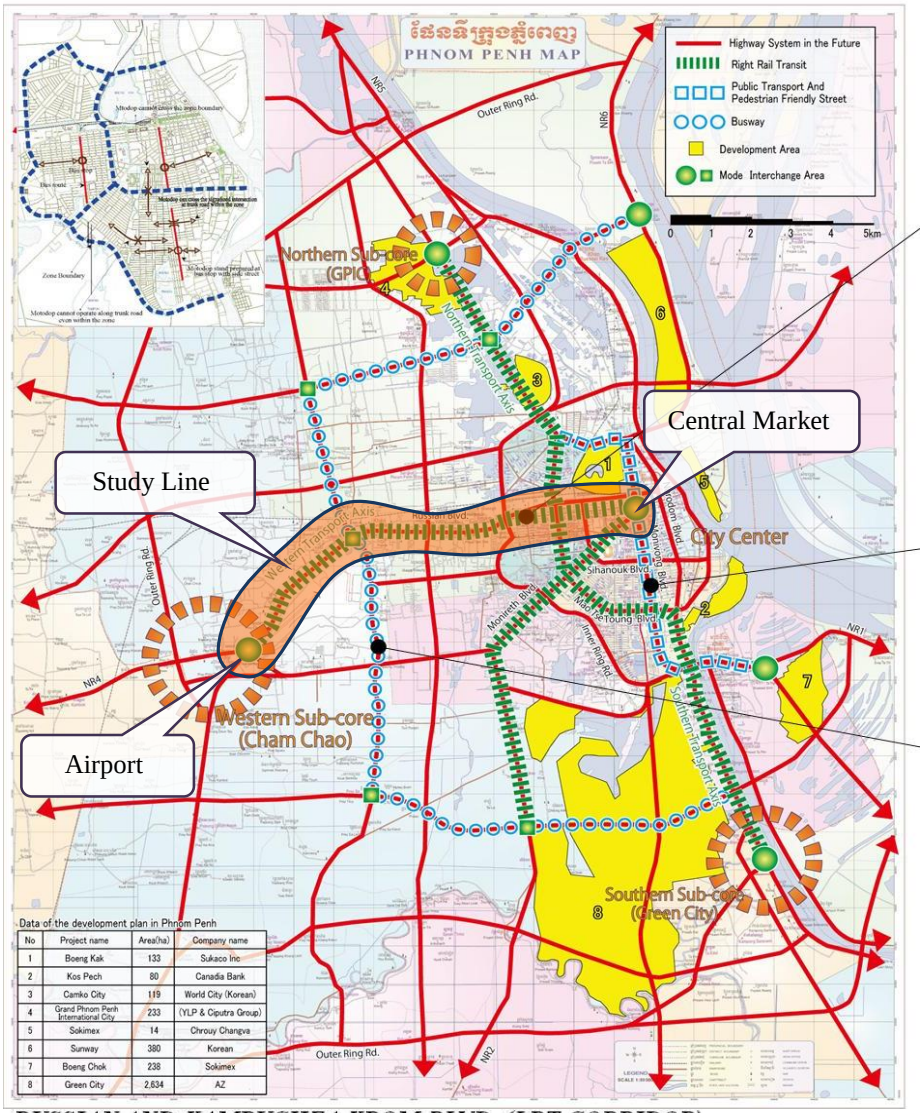
សំនួរ	មិនយល់ស្រប ⟹ យល់ស្រប						
	1	2	3	4	5	6	7
7. ប្រសិនបើ ខ្ញុំធ្វើដំណើរដោយរថភ្លើងក្រុង វានឹងមិនមានបញ្ហាចោទអ្វីដល់មិត្តខ្ញុំ រឺគ្រួសារខ្ញុំទេ							
8. មិត្តខ្ញុំ រឺគ្រួសារខ្ញុំ យល់ព្រមអោយ ខ្ញុំប្រើប្រាស់រថភ្លើងក្រុងនៅថ្ងៃខាងមុខ							
9. មិត្តខ្ញុំ រឺគ្រួសារខ្ញុំ យល់ថា ខ្ញុំគួរតែប្រើប្រាស់រថភ្លើងក្រុង							
10. មិត្តភ័ក្ត្រខ្ញុំជាច្រើន នឹងប្រើមធ្យោបាយធ្វើដំណើរដោយរថភ្លើងក្រុងនេះ							
11. ខ្ញុំ មានអារម្មណ៍ថាមានការគាបសង្កត់ពីសង្គមអោយខ្ញុំ ប្រើប្រាស់រថភ្លើងក្រុងនេះ							
12. ជាការងាយណាស់សំរាប់ខ្ញុំ ក្នុងការប្រើប្រាស់រថភ្លើងក្រុងនៅថ្ងៃខាងមុខ							
13. ខ្ញុំមានទំនុកចិត្តថា ខ្ញុំ អាចធ្វើដំណើរដោយរថភ្លើងក្រុងបាន							
14. ទោះបីខ្ញុំធ្វើដំណើរ រឺអត់ធ្វើដំណើរដោយរថភ្លើងក្រុងក៏ដោយ វាអាស្រ័យលើការសំរេចចិត្តរបស់ខ្ញុំទាំងស្រុង							
15. ការសំរេចចិត្តធ្វើដំណើរដោយរថភ្លើងក្រុងនៅថ្ងៃខាងមុខ វាស្ថិតនៅក្រោមការគ្រប់គ្រងរបស់ខ្ញុំ							
16. ខ្ញុំ អាចប្រើមធ្យោបាយដំណើរដោយរថភ្លើងក្រុងបានប្រសិនបើ ខ្ញុំចង់ប្រើ							
17. តាមការយល់ដឹង ខ្ញុំគិតថាប្រើប្រាស់រថភ្លើងក្រុងនៅថ្ងៃខាងមុខមិនមានការលំបាកអ្វីទេ							
18. ខ្ញុំ គួរតែប្រើមធ្យោបាយដំណើរដោយរថភ្លើងក្រុងនៅថ្ងៃខាងមុខ							
19. តាមការសំរេចចិត្តរបស់ខ្ញុំ ខ្ញុំនឹង ធ្វើដំណើរដោយរថភ្លើងក្រុង							
20. ខ្ញុំ ចង់ធ្វើដំណើរដោយរថភ្លើងក្រុង							
21. ខ្ញុំ មានគំរោងនឹងប្រើមធ្យោបាយដំណើរដោយរថភ្លើងក្រុង							
22. ខ្ញុំ នឹងជំរុញខ្លួនឯងអោយប្រើមធ្យោបាយដំណើរដោយរថភ្លើងក្រុង							
23. ប្រសិនបើ ខ្ញុំធ្វើដំណើរដោយរថភ្លើងក្រុងពិតមែននៅថ្ងៃខាងមុខ ខ្ញុំនឹងទៅដល់គោលដៅបានឆាប់រហ័ស។							
24. ការប្រើប្រាស់មធ្យោបាយធ្វើដំណើរដោយរថភ្លើងក្រុង វាអាស្រ័យទៅនឹងចំងាយនៃការធ្វើដំណើរ។							
25. ការប្រើប្រាស់មធ្យោបាយធ្វើដំណើរដោយរថភ្លើងក្រុង វាអាស្រ័យទៅនឹងតំលៃឈ្នួលនៃការធ្វើដំណើរ។							
26. ការប្រើប្រាស់មធ្យោបាយធ្វើដំណើរដោយរថភ្លើងក្រុង វាអាស្រ័យទៅនឹងកំរិតនៃការស្នះចរាចរណ៍។							
27. ការប្រើប្រាស់រថភ្លើងក្រុងនឹងកាត់បន្ថយការកកស្ទះចរាចរណ៍។							
28. ការប្រើប្រាស់មធ្យោបាយដំណើរដោយរថភ្លើងក្រុង នឹងជួយកាត់បន្ថយការគ្រោះថ្នាក់ចរាចរណ៍។							
29. ខ្ញុំ គិតថា មធ្យោបាយធ្វើដំណើរដោយរថភ្លើងក្រុង មានសុវត្ថិភាពល្អ។							
30. ខ្ញុំ គិតថាការកង្វក់ខ្យល់បរិយាកាសកំពុងស្ថិតក្នុងស្ថានភាពអាក្រក់ទៅៗ។							

សូមអរគុណសំរាប់ការសហការណ៍!!!

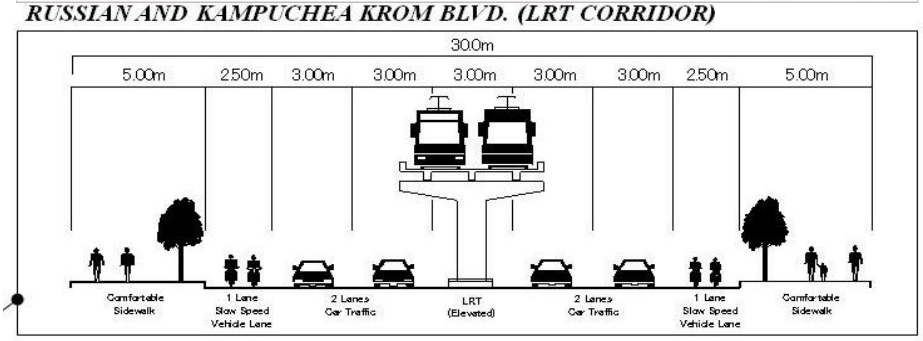
Appendix B: Main Questionnaire Survey (1)

Suppose there is a rail transit system running in Phnom Penh with 3 lines (see the map). Our research study will choose one of these lines, Airport line linking from City center (Central Market) to the western sub-core (Cham Chao). It's about 8.5 km long elevated along Russian and Kampuchea Krom Boulevard (as shown below). We will refer this rail transit system in the survey as future urban rail transit. We would like to ask you some questions for better understanding your future behavioural intention.

FUTUER PUBLIC TRANSPORT SYSTEM IN PHNOM PENH CITY



RUSSIAN AND KAMPUCHEA KROM BLVD. (LRT CORRIDOR)



Interviewer: _____Location: _____Survey date: _____time: _____

Study of Urban Rail Transit in Phnom Penh City

Please take a few minutes to answer these questions.

Section I: About Yourself

Age: _____ Gender: ❑ Female ❑ Male

Occupation: ❑ Student ❑ Teacher ❑ Employee ❑ Seller
❑ Civil servant ❑ Unemployed ❑ Other, please specify: _____

Education: ❑ Primary school ❑ Secondary school ❑ High school
❑ Associate bachelor ❑ Bachelor ❑ Higher than Bachelor.

Monthly income: ❑ None ❑ <=$100 ❑ $101-$200 ❑ $201-$300
❑ $301-$400$ ❑ 401-$500 ❑ $500-$1,000 ❑ >$1,000

Members in household (including yourself): _____

Number of vehicles in household: Car/Pick-up_____ Motorbike _____

Is there any vehicle available to you all the time? ❑ Yes ❑ No

Do you have driving license? ❑ Yes, for _____ years ❑ No

In which District/Commune have you lived? District: _____Commune: _____

During the last 4 weeks, I used private vehicles about _____ percent of my total travel.

When you travel along this corridor, what is the typical travel mode that you use the most?

❑ Motorbike ❑ Motor-taxi ❑ Other, please specify: _____

When you travel along this corridor, what is the typical trip purpose?

❑ Study ❑ Work ❑ Business ❑ Shopping

From: _____To: _____

Travel time (minutes): _____Cost (Riel): _____ Distance_____ Kilometers

Travel frequency for this purpose: _____ times/week

Within the last week, how often did you use the following modes of transport?

Private car:	❑ Everyday	❑ 4-5 days/week	❑ 2-3 days/week	❑ Rarely	❑ Never
Motorbike:	❑ Everyday	❑ 4-5 days/week	❑ 2-3 days/week	❑ Rarely	❑ Never
Bicycle:	❑ Everyday	❑ 4-5 days/week	❑ 2-3 days/week	❑ Rarely	❑ Never
Motor-taxi:	❑ Everyday	❑ 4-5 days/week	❑ 2-3 days/week	❑ Rarely	❑ Never

Section II: What do you think about Sky Rail System?

Please mark (√) the answer for the following questions:

Questions	Strongly Disagree ⇨ Strongly Agree						
	1	2	3	4	5	6	7
1. I have good feeling towards using the Sky Rail System.							
2. Using Sky Rail System on a regular basis is the right thing to do.							
3. I could use the Sky Rail System on a regular basis if I want to.							
4. I intend to use the Sky Rail System on a regular basis.							
5. For me, to use the Sky Rail System will be extremely pleasant.							
6. Using Sky Rail System on a regular basis will reduce traffic congestion.							
7. My friends or my family will be likely to use the Sky Rail System on a regular basis.							
8. The decision to use Sky Rail System on a regular basis is under my control.							
9. I should use the Sky Rail System because it is good for the environment.							
10. For me, to use the Sky Rail System is interesting.							
11. Whether I use the Sky Rail System on a regular basis is completely up to me.							
12. My intention to use Sky Rail System on a regular basis instead of my existing travel mode is strong.							
13. Using Sky Rail System on a regular basis will reduce traffic accidents.							
14. There will be many problems and difficulties with using the Sky Rail System on a regular basis.							
15. If I take the Sky Rail System on a regular basis, my friends or my family would have no problem with it.							
16. I would enjoy using the Sky Rail System.							
17. Most of people who are important to me will use the Sky Rail System on a regular basis.							
18. Using Sky Rail System on a regular basis will reduce air pollution.							
19. For me, to use the Sky Rail System on a regular basis is possible.							
20. I plan to use Sky Rail System on a regular basis instead of my existing travel mode.							
21. Most people whose opinions I value would approve my usage of the Sky Rail System on a regular basis.							
22. I will make an effort to use Sky Rail System on a regular basis.							
23. Most of people who are important to me think that I should use the Sky Rail System on a regular basis.							
24. I should use the Sky Rail System because it is good for society and the city.							

Section III: About your opinions

1. Have you heard about the Sky Rail System before? ❑ Yes ❑ No

2. How likely will you use it on a regular basis?

❑ Very unlikely ❑ Unlikely ❑ Not sure ❑ Likely ❑ Very likely

3. What do you think about the current traffic situation in Phnom Penh?

❑ Very bad ❑ Bad ❑ Not sure ❑ Good ❑ Very good

4. Do you think that the Sky Rail System will help alleviating traffic congestion in Phnom Penh?

❑ Very unlikely ❑ Unlikely ❑ Not sure ❑ Likely ❑ Very likely

5. Do you think that the Sky Rail System will help alleviating pollution issue in Phnom Penh?

❑ Very unlikely ❑ Unlikely ❑ Not sure ❑ Likely ❑ Very likely

6. When the Sky Rail System is available in the future,

How far is the place you live from the Sky Rail System? _____ Kilometers

Will you use it for this trip? ❑ Yes ❑ No

If "Yes", how much are you willing to pay? _____ Riel

If "Yes", how long do you think this trip will take? _____ Minutes

7. When the Sky Rail System is available in the future, please rank these factors in terms of their importance. (From 1, 2, 3 where 1 is the most important)

_____Access time to the station _____Access cost to the station

_____Cost of Sky Rail System _____Travel time of Sky Rail System

_____Comfort of Sky Rail System _____Egress time from the station

_____Egress cost from the station

8. Please mark (√) the following images for your current travel mode and Sky Rail System

Current Mode

	1	2	3	4	5	6	7	
Austere								Luxurious
Inferior								Superior
Unpleasant								Pleasant
Useless								Useful
Risky								Safe
Boisterous								Quiet

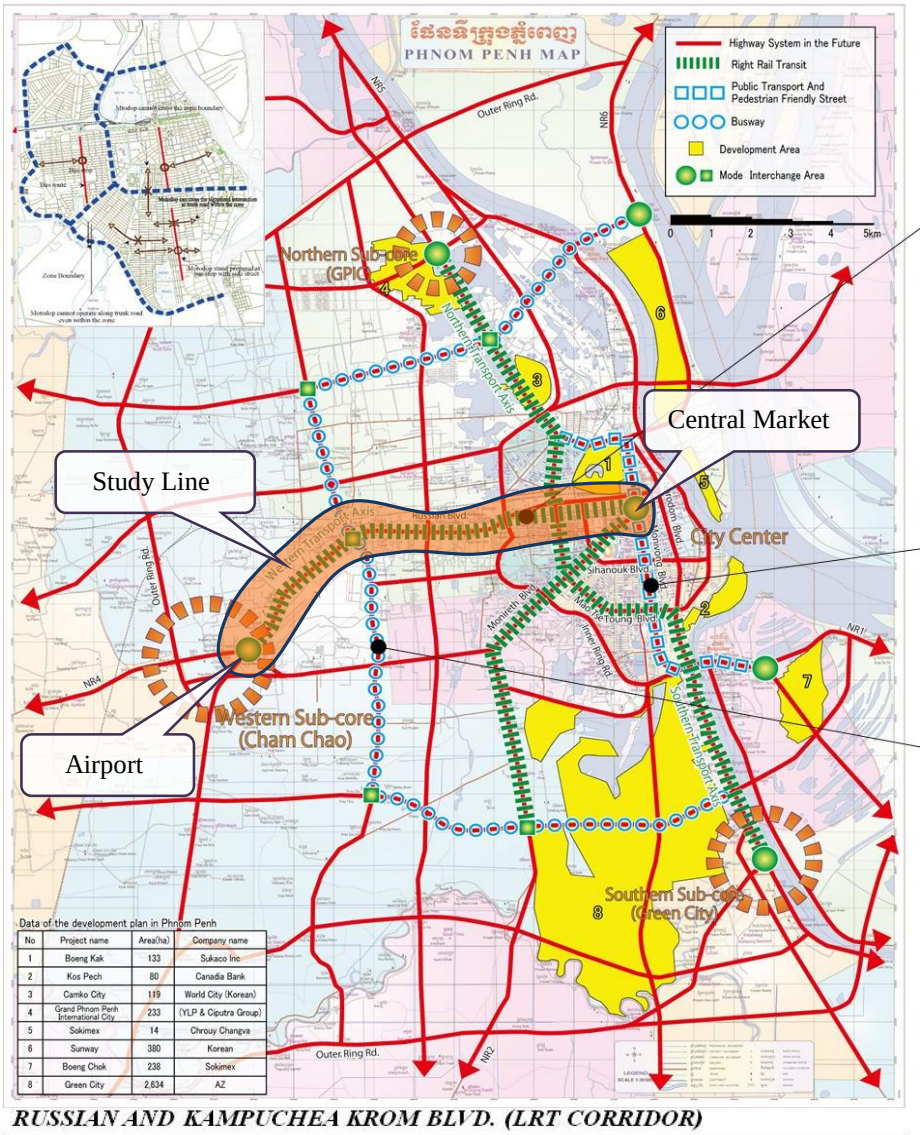
Sky Rail System

	1	2	3	4	5	6	7	
Boring								Exciting
Poor								Rich
Inconvenient								Convenient
Slow								Fast
Destructive								Constructive
Environmental Damaging								Environmental Friendly

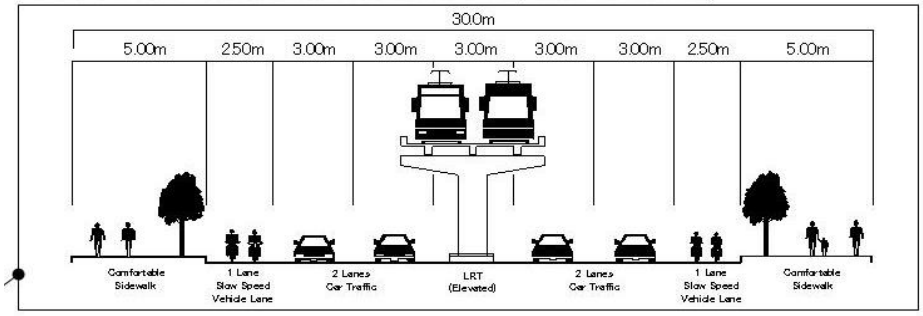
Thank You very much for Your Participation

ឧទាហរណ៍ថា មានខ្សែរថភ្លើងក្រុង រត់នៅក្នុងទីក្រុងភ្នំពេញ ចំនួន៣ខ្សែ ដូចក្នុងរូបភាពខាងក្រោម។ ១ខ្សែក្នុងចំនោម ខ្សែទាំង៣ គឺខ្សែដែលតភ្ជាប់ពី ផ្សារធំថ្មី ទៅអាកាសយានដ្ឋានអន្តរជាតិពោធិ៍ចិនតុង (ចោមចៅ) ត្រូវបានយកមកសិក្សា។ ខ្សែរថភ្លើងនេះ មានប្រវែងប្រមាណ៨,៥គីឡូម៉ែត្រ ដែលសង់នៅពីលើតាមបណ្តោយ មហាវិថីសហព័ន្ធរុស្ស៊ី និង មហាវិថីកម្ពុជាក្រោម ដូចបង្ហាញ ក្នុងរូបភាពខាងក្រោម។ យើងសន្មតថាខ្សែរថភ្លើងនេះ ជាខ្សែរថភ្លើងក្រុងនៅថ្ងៃខាងមុខ។ ដូច្នេះ យើងត្រូវការស្វង់មតិរបស់លោកអ្នកដើម្បីស្វែងយល់ពីគោលបំណងនៃការប្រើប្រាស់ខ្សែរថភ្លើងក្រុងនៅថ្ងៃខាងមុខ។

FUTUER PUBLIC TRANSPORT SYSTEM IN PHNOM PENH CITY



RUSSIAN AND KAMPUCHEA KROM BLVD. (LRT CORRIDOR)



អ្នកសំភាស: _____ទីកន្លែង: _____ កាលបរិច្ឆេទ: _____ម៉ោង: _____

ការសិក្សាខ្សែរថភ្លើងក្រុងនៅក្នុងទីក្រុងភ្នំពេញ

សូមមេត្តាផ្តល់ពេលវេលាពីរទៅបីនាទីដើម្បីឆ្លើយសំនួរខាងក្រោម:

ផ្នែកទី១: ពត៌មានអំពីខ្លួនអ្នក

អាយុ: _____ ភេទ: ❑ ស្រី ❑ ប្រុស

មុខរបរ: ❑ សិស្ស ❑ គ្រូបង្រៀន ❑ និយោជិត ❑ អ្នកលក់ដូរ
❑ មន្ត្រីរាជការ ❑ មិនមានការងារ ❑ ផ្សេងៗចូរបញ្ជាក់: _____

កំរិតវប្បធម៌: ❑ បឋមសិក្សា ❑ អនុវិទ្យាល័យ ❑ វិទ្យាល័យ ❑ បរិញ្ញប័ត្ររង
❑ បរិញ្ញប័ត្រ ❑ ខ្ពស់ជាងបរិញ្ញប័ត្រ

ប៉ៀវត្សប្រចាំខែ: ❑ មិនមាន ❑ <=$100 ❑ $101-$200 ❑ $201-$300
❑ $301-$400$ ❑ 401-$500 ❑ $500-$1,000 ❑ >$1,000

ចំនួនសមាជិកនៅក្នុងគ្រួសារ (រួមទាំងខ្លួនអ្នក): _____

ចំនួនរថយន្តនៅក្នុងផ្ទះ: រថយន្តតូច/រថយន្ត១បាំងកន្លះ _____ ម៉ូតូ _____

តើអ្នក អាចប្រើយានយន្តទាំងនោះបានគ្រប់ពេលដែលអ្នកចង់ប្រើដែរឬទេ? ❑ បាន ❑ មិនបាន

តើអ្នក មានប័ណ្ណបើកបរដែរឬទេ? ❑ មាន, សំរាប់ _____ ឆ្នាំ ❑ មិនមាន

តើសព្វថ្ងៃ អ្នកស្នាក់នៅក្នុងខណ្ឌ/សង្កាត់ណា? ខណ្ឌ: _____ សង្កាត់: _____

កាលពី៧សប្តាហ៍មុន ខ្ញុំ បានប្រើយានយន្តផ្ទាល់ខ្លួនប្រហែល_____ ភាគរយនៃការធ្វើដំណើររបស់ខ្ញុំ។

ជាញឹកញាប់ តើអ្នកប្រើប្រាស់មធ្យោបាយអ្វី ពេលដែលលោកអ្នកធ្វើដំនើរតាមមហាវិថីនេះ?

❑ ម៉ូតូ ❑ ម៉ូតូដុប ផ្សេងៗចូរបញ្ជាក់: _____

តើអ្នក ធ្វើដំនើរតាមមហាវិថីនេះក្នុងគោលបំណងអ្វី?

❑ សិក្សា ❑ ការងារ ❑ មុខជំនួញ ❑ ទិញឥវ៉ាន់

ចេញពី: _____ ទៅកាន់: _____

រយៈពេលធ្វើដំនើរ(នាទី): _____ តំលៃធ្វើដំនើរ(រៀល): _____ចំងាយ:_____ គីឡូម៉ែត្រ

ចំនួនធ្វើដំណើរ:_____ ដងក្នុង១សប្តាហ៍

កាលពីសប្តាហ៍មុន តើអ្នក បានធ្វើដំនើរដោយ មធ្យោបាយខាងក្រោមយ៉ាងដូចម្តេច?

រថយន្តផ្ទាល់ខ្លួន: ❑ រាល់ថ្ងៃ ❑ 4-5 ថ្ងៃ/សប្តាហ៍ ❑ 2-3 ថ្ងៃ/សប្តាហ៍ ❑ កំរិ ❑ មិនមាន

ម៉ូតូ: ❑ រាល់ថ្ងៃ ❑ 4-5 ថ្ងៃ/សប្តាហ៍ ❑ 2-3 ថ្ងៃ/សប្តាហ៍ ❑ កំរិ ❑ មិនមាន

កង់: ❑ រាល់ថ្ងៃ ❑ 4-5 ថ្ងៃ/សប្តាហ៍ ❑ 2-3 ថ្ងៃ/សប្តាហ៍ ❑ កំរិ ❑ មិនមាន

ម៉ូតូដុប: ❑ រាល់ថ្ងៃ ❑ 4-5 ថ្ងៃ/សប្តាហ៍ ❑ 2-3 ថ្ងៃ/សប្តាហ៍ ❑ កំរិ ❑ មិនមាន

ផ្នែកទី២: តើអ្នកគិតយ៉ាងដូចម្តេចអំពីរថភ្លើងអាកាស?

ចូរគូសសញ្ញា(√) ដើម្បីឆ្លើយនឹងសំនួរខាងក្រោម:

សំនួរ	មិនយល់ស្រប ⟹ យល់ស្រប						
	1	2	3	4	5	6	7
1. ខ្ញុំ មានអារម្មណ៍ល្អចំពោះការប្រើរថភ្លើងអាកាស							
2. ការប្រើរថភ្លើងអាកាសជាប្រចាំ គឺជាការត្រឹមត្រូវដែលខ្ញុំត្រូវធ្វើ							
3. ខ្ញុំ អាចប្រើរថភ្លើងអាកាសប្រសិនបើខ្ញុំចង់ប្រើ							
4. ខ្ញុំ មានបំណងនឹងប្រើ រថភ្លើងអាកាសជាប្រចាំ							
5. សំរាប់ខ្ញុំ វាពិតជាសប្បាយក្នុងការប្រើរថភ្លើងអាកាស							
6. ការប្រើរថភ្លើងអាកាសជាប្រចាំ នឹងកាត់បន្ថយការកកស្ទះចរាចរណ៍							
7. មិត្តខ្ញុំ រឺគ្រួសារខ្ញុំ ទំនងជាពេញចិត្តប្រើរថភ្លើងអាកាសជាប្រចាំ							
8. ការសំរេចចិត្ត ប្រើរថភ្លើងអាកាសជាប្រចាំ វា ស្ថិតនៅក្រោមការពិចារណារបស់ខ្ញុំ							
9. ខ្ញុំ គួរតែប្រើរថភ្លើងអាកាសពីព្រោះវាល្អសំរាប់បរិស្ថាន							
10. សំរាប់ខ្ញុំ ការប្រើរថភ្លើងអាកាសគឺគួរអោយចាប់អារម្មណ៍							
11. ទោះជាខ្ញុំប្រើ រថភ្លើងអាកាសជាប្រចាំ រឺ មិនប្រើ វាអាស្រ័យលើការសំរេចចិត្តរបស់ខ្ញុំ							
12. ខ្ញុំ មានបំណងនឹងប្រើ រថភ្លើងអាកាសជាប្រចាំ ជាង មធ្យោបាយដែលខ្ញុំកំពុងតែប្រើ							
13. ការប្រើរថភ្លើងអាកាសជាប្រចាំ នឹងកាត់បន្ថយ ការគ្រោះថ្នាក់ចរាចរណ៍							
14. វានឹង មានបញ្ហានិងការលំបាកយ៉ាងច្រើនចំពោះការប្រើ រថភ្លើងអាកាសជាប្រចាំ							
15. ប្រសិនបើ ខ្ញុំប្តូរមកធ្វើដំណើរដោយរថភ្លើងអាកាសជាប្រចាំ មិត្តខ្ញុំ រឺគ្រួសារខ្ញុំ នឹងមិនមានបញ្ហាជាមួយការសំរេចចិត្តរបស់ខ្ញុំទេ							
16. ខ្ញុំ រីករាយនឹងប្រើរថភ្លើងអាកាស							
17. មនុស្សភាគច្រើន ដែលសំខាន់សំរាប់ខ្ញុំ នឹងប្រើរថភ្លើងអាកាសជាប្រចាំ							
18. ការប្រើប្រាស់មុធ្យោបាយដំណើរដោយរថភ្លើងអកាស នឹងជួយកាត់បន្ថយកង្វក់ខ្យល់បរិយាកាស							
19. សំរាប់ខ្ញុំ ការប្រើរថភ្លើងអាកាសជាប្រចាំគឺអាចធ្វើទៅបាន							
20. ខ្ញុំគ្រោង នឹងប្រើ រថភ្លើងអាកាសជាប្រចាំ ជំនួសអោយ មធ្យោបាយ ដែលខ្ញុំកំពុងតែប្រើ							
21. មនុស្សភាគច្រើន ដែលមានមតិយោបល់ល្អៗ នឹងយល់ស្របជាមួយការសំរេចចិត្តប្រើរថភ្លើង អាកាសជាប្រចាំរបស់ខ្ញុំ							
22. ខ្ញុំ នឹងព្យាយាមប្រើរថភ្លើងអាកាសជាប្រចាំ							
23. មនុស្សភាគច្រើន ដែលសំខាន់សំរាប់ខ្ញុំ គិតថា ខ្ញុំគួរតែប្រើ រថភ្លើង អាកាសជាប្រចាំ							
24. ខ្ញុំ នឹងគួរតែប្រើរថភ្លើងអាកាស ពីព្រោះវាល្អសំរាប់សង្គម និងទីក្រុង							

ផ្នែកទី៣: អំពីមតិយោបលរបស់អ្នក

1. តើអ្នកធ្លាប់បានលឺពតិមានអំពីរថភ្លើងអាកាសកាលពីមុនដែរឬទេ? ❑ ធ្លាប់ ❑ មិនធ្លាប់

2. តើអ្នក ទំនងជាប្រើរថភ្លើងអាកាសជាប្រចាំ?

❑ មិនប្រើ ❑ ប្រហែលជាមិនប្រើ ❑ ដឹងមិនច្បាស់ ❑ ប្រហែលជាប្រើ ❑ ច្បាស់ជាប្រើ

3. តើអ្នក គិតដូចម្តេចអំពីស្ថានភាពចរាចរណ៍បច្ចុប្បន្ននៅទីក្រុងភ្នំពេញ?

❑ អាក្រក់ណាស់ ❑ អាក្រក់ ❑ ដឹងមិនច្បាស់ ❑ ល្អ ❑ ល្អណាស់

4. តើអ្នក គិតថាបណ្តាញរថភ្លើងអាកាសនឹងជួយសំរាលការកកស្ទះចរាចរណ៍នៅទីក្រុងភ្នំពេញ?

❑ មិនអាច ❑ ប្រហែលជាមិនអាច ❑ ដឹងមិនច្បាស់ ❑ ប្រហែលជាអាច ❑ ច្បាស់ជាអាច

5. តើអ្នកគិតថាបណ្តាញរថភ្លើងអាកាសនឹងជួយធ្វើអោយបញ្ហាកង្វក់អាកាសទីក្រុងភ្នំពេញមានភាពធូរស្រាលឡើង?

❑ មិនអាច ❑ ប្រហែលជាមិនអាច ❑ ដឹងមិនច្បាស់ ❑ ប្រហែលជាអាច ❑ ច្បាស់ជាអាច

6. នៅពេលដែលបណ្តាញរថភ្លើងអាកាស អាចប្រើប្រាស់បាននៅថ្ងៃអនាគត:

តើកន្លែងស្នាក់នៅរបស់អ្នក នៅឆ្ងាយពីបណ្តាញរថភ្លើងអាកាសប៉ុន្មានគីឡូម៉ែត្រ? _____គីឡូម៉ែត្រ

តើអ្នកនឹងប្រើប្រាស់វា? ❑ ប្រើប្រាស់ ❑ មិនប្រើប្រាស់

ប្រសិនបើ "ប្រើប្រាស់" តើអ្នក ចង់ចំនាយប្រាក់ប៉ុន្មាន? _____ រៀល

ប្រសិនបើ "ប្រើប្រាស់" តើអ្នក គិតថានឹងប្រើនឹងធ្វើដំរណើររយៈពេលប៉ុន្មាននាទី? _____ នាទី

7. នៅពេលដែលបណ្តាញរថភ្លើងអាកាស អាចប្រើប្រាស់បាននៅថ្ងៃអនាគត សូមមេត្តាបង់លេខជាចំនាត់ថ្នាក់ខាងក្រោមនេះ (ពីលេខ ១, ២, ៣ ដែលលេខ១ គឺសំខាន់បំផុត)

_____រយៈពេលធ្វើដំណើរមកដល់ស្តានីយ _____តំលៃធ្វើដំណើរមកដល់ស្តានីយ៍

_____តំលៃធ្វើដំណើររបស់រថភ្លើងអាកាស _____រយៈពេលធ្វើដំណើររបស់រថភ្លើងអាកាស

_____ជាសុកភាពរបស់រថភ្លើងអាកាស _____រយៈពេលធ្វើដំណើរពីស្តានីយ៍ទៅគោលដៅ

_____តំលៃនៃការធ្វើដំណើរពីស្តានីយ៍

8. ចូរគូសសញ្ញា(√) ដើម្បីឆ្លើយនឹងសំនួរខាងក្រោមអំពី មធ្យោបាយធ្វើដំនើរបច្ចុប្បន្ននិង បណ្តាញរថភ្លើងអាកាស:

មធ្យោបាយធ្វើដំនើរបច្ចុប្បន្ន

	1	2	3	4	5	6	7	
មិនជាសុកភាព								ជាសុកភាព
ទាបជាងគេ								ប្រសើរជាងគេ
មិនសប្បាយចិត្ត								សប្បាយចិត្ត
គ្មានប្រយោជន៍								មានប្រយោជន៍
មិនសុវត្តិភាព								សុវត្តិភាព
អ៊ូអរ								ស្ងប់ស្ងាត់

បណ្តាញរថភ្លើងអាកាស

	1	2	3	4	5	6	7	
ធុញទ្រាន់								រីករាយ
ក្រ								មាន
មិនងាយស្រួល								ងាយស្រួល
យឺត								លឿន
ធ្វើអោយវិនាស								មានប្រយោជន៍
ខូចបរិស្ថាន								បរិស្ថានល្អ

សូមអរគុណសំរាប់ការសហការណ៍!!!

Appendix C: Main Questionnaire Survey (2)

Location: _____Survey date: _____time: _____

Study of Drivers' Behavior in Phnom Penh City

Dear respondents, the data in this study will be used for research purpose only. Please take a few minutes out of your valuable time to answer these questions.

Section I: About Yourself

1. Age: _____ Gender: ❑ Female ❑ Male

2. Occupation: ❑ Student ❑ Teacher ❑ Employee ❑ Seller ❑ Employer
❑ Civil servant ❑ Unemployed ❑ Other, please specify: _____

3. Education: ❑ Primary school ❑ Secondary school ❑ High school
❑ Associate bachelor ❑ Bachelor ❑ Higher than Bachelor.

4. Monthly income: ❑ None ❑ <=$100 ❑ $101-$200 ❑ $201-$300
❑ $301-$400$ ❑ 401-$500 ❑ $500-$1,000 ❑ >$1,000

5. Members in household (including yourself): _____

6. Number of vehicles in household: Car/Pick-up_____Motorbike_____

7. Do you have driving license? ❑ Yes, for _____ years ❑ No

8. What is the typical travel mode that you use the most?
❑ Motorcycle ❑ Motor-taxi ❑ Private car ❑ Taxi car ❑ Other: _____

Section II: About drunk driving behavior

Please mark (√) the answer for the following questions:

1. How often do you have a drink containing alcohol?
❑ Never ❑ Monthly or less ❑ 2-4 times/month ❑ 2-3 times/week ❑ 4 or more times a week

If your answer in Q.1 is "Never", please skip to answer Q.9.

2. How many days per week do you drive after drinking even a small amount of alcohol?
❑ < 1 ❑ 1 or 2 ❑ 3 or 4 ❑ 5 or 6 ❑ Every day

3. How many standard drinks containing alcohol do you have on a typical day when drinking?
❑ 1 or 2 ❑ 3 or 4 ❑ 5 or 6 ❑ 7 to 9 ❑ 10 or more

4. How often do you have six or more drinks on one occasion?
❑ Never ❑ Less than monthly ❑ Monthly ❑ Weekly ❑ Daily or almost daily

5. Have you or someone else been injured as a result of your drinking? ❑ No ❑ Yes

6. Has a relative or friend, doctor or other health worker been concerned about your drinking or suggested you cut down?

❑ No ❑ Yes, during the past year ❑ Yes, recently

7. Have you ever been pulled over and punished for drunk driving?

❑ No ❑ Yes, once ❑ Yes, more than once

8. Do you drive or did you drive after drinking when you are/were under the age of 18? ❑ No ❑ Yes

9. Do you know anyone who has been punished for drunk driving? ❑ No ❑ Yes

10. Did you get into a car with driver who has been drinking and might be drunk?

❑ No ❑ Yes, once ❑ Yes, more than one time

11. Have you ever asked someone who you know to be drunk not to drive?

❑ No ❑ Yes, once ❑ Yes, more than one time

12. Have you ever been in a car in which the driver was pulled over and found to be above the legal blood alcohol content limit? ❑ No ❑ Yes, once ❑ Yes, more than one time

13. Do you know anyone who had trouble (has harmed him/herself) during driving under the influence of alcohol? ❑ No ❑ Yes

14. Have you ever join the seminar about drunk driving?

❑ Never ❑ May be ❑ One times ❑ Several times ❑ Many times

Questions	**Strongly Disagree⇨ Strongly Agree**				
	1	2	3	4	5
1. I think that driving after little drinking of alcohol is ok.					
2. I think that driving for short distance after drinking alcohol is ok.					
3. I think that drunk driving is bad manner and dangerous.					
4. I think that education about danger of drunk driving is very important.					
5. I think that law of drunk driving should be made more severe.					
6. I think that the control of drunk driving should be increased.					
7. Despite driving under the influence of alcohol, it would not cause accident.					
8. I think that judgment/reaction behavior will be lower if driving under the influence of alcohol.					
9. I think that it would be risky and dangerous if driving under the influence of alcohol.					
10. If I drink alcohol, I will not drive any vehicle.					

Questions	Strongly Disagree⇨ Strongly Agree				
	1	2	3	4	5
11. If I drink alcohol, I use public transport (current public transportation mode: Taxi car, Motor taxi, Took took...).					
12. If I drink alcohol, I use public transport (future public transportation mode: bus, tramway, sky train….).					
13. If I joined a party and I were a driver. I would not drink alcohol even though friends or other important people ask me to drink.					

Section III: About distruction and careless driving

Please mark (√) the answer for the following questions:

1. How often do you use phone during driving?

❑ Never ❑ Rarely ❑ Sometime ❑ Often ❑ Every time

2. Do you always wear helmet/ seat-belt when traveling?

❑ Never ❑ Rarely ❑ Sometime ❑ Often ❑ Every time

3. Do you have video player and screen in your car?

❑ No ❑ Yes, only player ❑ Yes, have both

4. Have you ever smoked during driving vehicle?

❑ Never ❑ Rarely ❑ Sometime ❑ Often ❑ Every time

5. Have you ever driven or ridden vehicle in the condition of stress driving?

❑ No ❑ Yes, once ❑ Yes, more than one time

6. Have you ever driven or ridden vehicle in the condition of fatigue driving?

❑ No ❑ Yes, once ❑ Yes, more than one time

7. Have you ever driven or ridden vehicle in the condition of arousal driving?

❑ No ❑ Yes, once ❑ Yes, more than one time

8. Have you ever driven or ridden over speed limit? (in urban area: 30 khm/h for motorcycle or tricycle and 40km/h for car)

❑ Never ❑ Rarely ❑ Sometime ❑ Often ❑ Every time

9. How often do you have vehicle checked?

❑ Never ❑ Once every 2 years ❑ Once per year ❑ Few times per year

10. How often do you give priority to pedestrians walking along and crossings the road?

❑ Never ❑ Rarely ❑ Sometime ❑ Often ❑ Every time

11. Have you ever violated the traffic light at an intersection (i.e. keep going during yellow light or red light)? ❑ No ❑ Yes

12. How often do you violate the traffic light at an intersection (i.e. keep going during yellow light or red light)?

❑ Never ❑ Rarely ❑ Sometime ❑ Often ❑ Every time

Questions	Strongly Disagree⇨ Strongly Agree				
	1	2	3	4	5
1. I think that making or receiving phone call during driving is bad manner and dangerous.					
2. I think that it would be risky and dangerous if driving without wearing helmet/seat-belt.					
3. I think that stress driving is dangerous and may cause the traffic accident.					
4. I think that fatigue driving/arousal driving is dangerous and risk causing traffic accident.					
5. I think that driving with unchecked vehicle/old vehicle is dangerous and risk causing traffic problems.					
6. I think that severe punishment (no seatbelt, no helmet, phone call,...etc) is important to reduce traffic accident.					
7. I think that high speed driving/over taking in city is dangerous and may cause traffic accident.					
8. I think that I should not drive in the condition of arousal, stress, fatigue driving.					
9. I think that I should not pick up or make phone call during driving.					
10. I think that it would be risky and dangerous if smoking/watching video during driving.					

Thank You very much for Your Participation

ទីកន្លែង: _____ថ្ងៃសំភាស: _____ពេលវេលា: _____

ការសិក្សាពីឥរិយាបទអ្នកបើកបរនៅទីក្រុងភ្នំពេញ

សូមមេត្តាផ្តល់ពេលវេលាបួនទៅប្រាំនាទីដើម្បីឆ្លើយសំនួរខាងក្រោម:

ផ្នែកទី១: ពត៌មានអំពីខ្លួនអ្នក

1. អាយុ: _____ ភេទ: ❑ ស្រី ❑ ប្រុស

2. មុខរបរ: ❑ សិស្ស/និស្សិត ❑ គ្រូបង្រៀន ❑ និយោជិត ❑ និយោជក ❑ អ្នកលក់ដូរ
❑ មន្ត្រីរាជការ ❑ មិនមានការងារ ❑ ផ្សេងៗចូរបញ្ជាក់: _____

3. កំរិតវប្បធម៌: ❑ បឋមសិក្សា ❑ អនុវិទ្យាល័យ ❑ វិទ្យាល័យ
❑ បរិញ្ញប័ត្ររង ❑ បរិញ្ញប័ត្រ ❑ ខ្ពស់ជាងបរិញ្ញប័ត្រ

4. ប៉ៃវត្សប្រចាំខែ: ❑ មិនមាន ❑ <=$100 ❑ $101-$200 ❑ $201-$300
❑ $301-$400$ ❑ 401-$500 ❑ $500-$1,000 ❑ >$1,000

5. ចំនួនសមាជិកនៅក្នុងគ្រួសារ (រួមទាំងខ្លួនអ្នក): _____

6. ចំនួនរថយន្តនៅក្នុងផ្ទះ: រថយន្តតូច/រថយន្ត១បាំងកន្លះ _____ម៉ូតូ_____

7. តើអ្នក មានប័ណ្ណបើកបរដែរឬទេ? ❑ មាន, សំរាប់ _____ ឆ្នាំ ❑ មិនមាន

8. ជាញឹកញាប់ តើអ្នកប្រើប្រាស់មធ្យោបាយមួយណានៅពេលធ្វើដំនើរ?
❑ ម៉ូតូ ❑ ម៉ូតឌុប ❑ រថយន្ត ❑ រថយន្តឈ្នួល(តាក់ស៊ី) ❑ ផ្សេងៗចូរបញ្ជាក់: _____

ផ្នែកទី២: ឥរិយាបទក្នុងការបើកបរក្រោមឥទ្ធិពលគ្រឿងស្រវឹង

ចូរគូសសញ្ញា(√) ដើម្បីឆ្លើយនឹងសំនួរខាងក្រោម:

1. តើអ្នកសេពគ្រឿងស្រវឹងញឹកញាប់កំរិតណា?
❑ មិនដែល ❑ ១ខែម្តង ឬតិចជាង ❑ ២-៤ដង/១ខែ ❑ ២-៣ដង/១សប្តាហ៍ ❑ ៤ ឬច្រើនដង/១សប្តាហ៍

ប្រសិនបើចំលើយសំនួរទី១ "មិនដែល" សូមរំលងទៅសំនួរទី៩។

2. តើអ្នក ជិះ ឬ បើកបរដោយសេពគ្រឿងស្រវឹង (ទោះបីក្នុងកំរិតទាប) ប៉ុន្មានថ្ងៃក្នុងមួយសប្តាហ៍?
❑ < ១ ថ្ងៃ ❑ ១ ឬ ២ ថ្ងៃ ❑ ៣ ឬ ៤ ថ្ងៃ ❑ ៥ ឬ ៦ ថ្ងៃ ❑ រៀងរាល់ថ្ងៃ

3. តើអ្នក សេពគ្រឿងស្រវឹង ប៉ុន្មានកំប៉ុង/ដប ក្នុងថ្ងៃធម្មតា (គ្មានកម្មវិធីផ្សេងៗ)?
❑ ១ ឬ ២ ❑ ៣ ឬ ៤ ❑ ៥ ឬ ៦ ❑ ៧ ឬ ៩ ❑ ១០ ឬ ច្រើន

4. តើអ្នក សេពគ្រឿងស្រវឹងដែលមានចំណុះស្មើនឹង ៦កំប៉ុង/ដប រឺលើសពីនេះនៅក្នុងពិធីមួយ ញឹកញាប់កំរិតណា?

❑ មិនធ្លាប់ ❑ ១ម្តងក្នុង ២រឺ៣ខែ ❑ រៀងរាល់ខែ ❑ រៀងរាល់សប្តាហ៍ ❑ រៀងរាល់ថ្ងៃ

5. តើអ្នក រឺនរណាម្នាក់ ធ្លាប់រងគ្រោះថ្នាក់ដោយសារការសេពគ្រឿងស្រវឹងរបស់អ្នកដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់

6. តើអ្នក មានសាច់ញាតិ មិត្តភ័ក្ត្រ រឺគ្រូពេទ្យ ធ្លាប់អោយយោបល់ រឺស្នើរអោយកាត់បន្ថយរឺបញ្ឈប់ការសេពគ្រឿងស្រវឹងដែររឺទេ?

❑ មិនមាន ❑ មាន កាលពីឆ្នាំកន្លងទៅ ❑ មាន កាលពីថ្មីៗនេះ

7. តើអ្នក ធ្លាប់ត្រូវបានជាកពិន័យពីការបើកបរនៅពេលស្រវឹងដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់ ១ម្តង ❑ ធ្លាប់ ច្រើនដង

8. តើអ្នក ធ្លាប់បើកបរដោយសេពគ្រឿងស្រវឹង ពេលដែលអ្នកមានអាយុក្រោម១៨ឆ្នាំដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់

9. តើអ្នក មានស្គាល់អ្នកណាម្នាក់ដែលត្រូវបានជាកពិន័យពីការបើកបរនៅពេលស្រវឹងដែររឺទេ?

❑ មិនស្គាល់ ❑ ស្គាល់

10. តើអ្នក ធ្លាប់ជិះឡានជាមួយអ្នកបើកបរដែលសេពគ្រឿងស្រវឹង រឺស្រវឹងដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់ ១ដង ❑ ធ្លាប់ ច្រើនដង

11. តើអ្នក ធ្លាប់ស្នើរអោយអ្នកបើកបរដែលសេពគ្រឿងស្រវឹង រឺស្រវឹងកុំអោយបើកបរដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់ ១ដង ❑ ធ្លាប់ ច្រើនដង

12. តើអ្នក ធ្លាប់ជិះឡានជាមួយអ្នកបើកបរដែលត្រូវបានជាកពិន័យពីការបើកបរដែលមានកំរិតជាតិស្រវឹងលើសពីការកំនត់ដែររឺទេ? ❑ មិនធ្លាប់ ❑ ធ្លាប់ ១ម្តង ❑ ធ្លាប់ ច្រើនដង

13. តើអ្នក មានស្គាល់អ្នកណាម្នាក់ដែលបង្កបញ្ហាអោយខ្លួនដោយសារការបើកបរក្រោមឥទ្ធិពលគ្រឿងស្រវឹងដែររឺទេ? ❑ មិនស្គាល់ ❑ ស្គាល់

14. តើអ្នកធ្លាប់ចូលរួមសិក្ខាសាលាអំពីការបើកបរមានជាតិស្រវឹងដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់ ❑ ធ្លាប់ ១ដង ❑ ធ្លាប់ ២ រឺ៣ដង ❑ ធ្លាប់ច្រើនដង

សំនួរ	**មិនយល់ស្រប ⟹ យល់ស្រប**				
	1	2	3	4	5
1. ខ្ញុំគិតថា ការសេពគ្រឿងស្រវឹងតិចតួច ហើយបើកបរ វាគ្មានបង្កបញ្ហាអ្វីទេ។					

សំនួរ	មិនយល់ស្រប ⟹ យល់ស្រប				
	1	2	3	4	5
2. ខ្ញុំគិតថា ការសេពគ្រឿងស្រវឹង ហើយបើកបរក្នុងចំងាយខ្លី វាគ្មានបង្កបញ្ហាអ្វីទេ។					
3. ខ្ញុំគិតថា ការបើកបរនៅពេលស្រវឹង គឺជាឥរិយាបទអាក្រក់ និងគ្រោះថ្នាក់បំផុត។					
4. ខ្ញុំគិតថា ការអប់រំអំពីគ្រោះថ្នាក់នៃការបើកបរនៅពេលស្រវឹង មានសារៈសំខាន់ណាស់។					
5. ខ្ញុំគិតថា ច្បាប់ស្តីពីការបើកបរមានជាតិស្រវឹង ត្រូវតែធ្វើអោយតឹងរឹង និងពិន័យអោយធ្ងន់បំផុត។					
6. ខ្ញុំគិតថា កន្លែងត្រួតពិនិត្យការបើកបរមានជាតិគ្រឿងស្រវឹង ត្រូវតែបង្កើនថែមទៀត។					
7. ទោះបីជា ខ្ញុំបើកបរស្ថិតក្រោមឥទ្ធិពលគ្រឿងស្រវឹងក៏ដោយ ក៏វាមិនបង្កគ្រោះថ្នាក់ចរាចរណ៍ដែរ។					
8. ខ្ញុំគិតថា ការរិនិច្ឆ័យ និងការប្រតិកម្ម នឹងថយចុះប្រសិនបើបើកបរក្រោមឥទ្ធិពលគ្រឿងស្រវឹង។					
9. ខ្ញុំគិតថា វាមានការប្រថុយប្រថាន និងគ្រោះថ្នាក់ណាស់ ប្រសិនបើបើកបរបិតក្រោមឥទ្ធិពលគ្រឿងស្រវឹង។					
10. បើសិនជាខ្ញុំសេពគ្រឿងស្រវឹង ខ្ញុំនឹងមិនជិះរឺបើកបរយានយន្តទេ។					
11. បើសិនជាខ្ញុំសេពគ្រឿងស្រវឹង ខ្ញុំនឹងប្រើប្រាស់មធ្យោបាយធ្វើដំណើរសាធារណៈដែលមានក្នុងពេលបច្ចុប្បន្ន (រថយន្តតាក់ស៊ី ម៉ូតូឌុប តុកតុក។ល។)					
12. បើសិនជាខ្ញុំសេពគ្រឿងស្រវឹង ខ្ញុំនឹងប្រើប្រាស់មធ្យោបាយធ្វើដំណើរសាធារណៈនាពេលអនាគត (រថយន្តក្រុង រថភ្លើងក្រុង ។ល។)					
13. បើសិនជាខ្ញុំចូលរួមពិធីមួយ ហើយខ្ញុំជាអ្នកបើកបរ។ ខ្ញុំនឹងមិនសេពគ្រឿងស្រវឹងទេ ទោះបីជាមិត្តភ័ក្ត្ររឺមនុស្សសំខាន់សុំអោយផឹកក៏ដោយ។					

ផ្នែកទី៣: ឥរិយាបទក្នុងការបើកបរដោយធ្វេសប្រហែស

ចូរគូសសញ្ញា(√) ដើម្បីឆ្លើយនឹងសំនួរខាងក្រោម:

1. តើជាញឹកញាប់អ្នក ប្រើប្រាស់ទូរស័ព្ទអំឡុងពេលបើកបរដែររឺទេ?

❑ មិនប្រើសោះ ❑ កំរប្រើ ❑ ប្រើពេលខ្លះ ❑ ប្រើជាញឹកញាប់ ❑ ប្រើគ្រប់ពេល

2. តើអ្នក តែងតែពាក់មួកការពារ រឺខ្សែក្រវ៉ាត់ការពារនៅពេលបើកបរដែររឺទេ?

❑ មិនប្រើសោះ ❑ កំរ៉ប្រើ ❑ ប្រើពេលខ្លះ ❑ ប្រើជាញឹកញាប់ ❑ ប្រើគ្រប់ពេល

3. តើអ្នក មានម៉ាស៊ីនចាក់រីស៊ីឌី និងអេក្រង់ទូរទស្សន៍នៅក្នុងរថយន្តរបស់អ្នកដែររឺទេ?

❑ មិនមាន ❑ មានតែម៉ាស៊ីនចាក់រីស៊ីឌី ❑ មានទាំងពីរ

4. តើអ្នកធ្លាប់ ជក់បារីអំឡុងពេលបើកបរដែររឺទេ?

❑ មិនដែលសោះ ❑ កំរ៉ ❑ ពេលខ្លះ ❑ ញឹកញាប់ ❑ គ្រប់ពេល

5. តើអ្នក ធ្លាប់ជិះ រឺ បើកបរយានយន្តពេលមានអារម្មណ៍តានតឹង តប់ប្រមល់(stress)ដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់ ១ដង ❑ ធ្លាប់ ច្រើនដង

6. តើអ្នក ធ្លាប់ជិះ រឺ បើកបរយានយន្តបិតក្នុងភាពនឿយហត់ដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់ ១ដង ❑ ធ្លាប់ ច្រើនដង

7. តើអ្នក ធ្លាប់ជិះ រឺ បើកបរយានយន្តបិតក្នុងភាពងងុយគេង រឹងក់ដែររឺទេ?

❑ មិនធ្លាប់ ❑ ធ្លាប់ ១ដង ❑ ធ្លាប់ ច្រើនដង

8. តើអ្នក ធ្លាប់ជិះ រឺ បើកបរយានយន្តហួសពីល្បឿនកំណត់ដែររឺទេ? (ក្នុងទីក្រុង ៣០គីឡូម៉ែត្រក្នុង១ម៉ោង សំរាប់ទោចក្រយាន្ត និង៤០គីឡូម៉ែត្រក្នុង១ម៉ោង សំរាប់រថយន្ត)

❑ មិនដែលសោះ ❑ កំរ៉ ❑ ពេលខ្លះ ❑ ញឹកញាប់ ❑ គ្រប់ពេល

9. ជាញឹកញាប់ តើអ្នកត្រួតពិនិត្យយានយន្តរបស់អ្នកប៉ុន្មានដង?

❑ មិនដែលសោះ ❑ ២ឆ្នាំ១ដង ❑ ១ដងក្នុង១ឆ្នាំ ❑ ២ រឺ៣ដងក្នុង១ឆ្នាំ

10. ជាញឹកញាប់ តើអ្នកផ្តល់សិទ្ធិអាទិភាពដល់អ្នកធ្វើដំនើរដើរ និងឆ្លងផ្លូវដែររឺទេ?

❑ មិនដែលសោះ ❑ កំរ៉ ❑ ពេលខ្លះ ❑ ញឹកញាប់ ❑ គ្រប់ពេល

11. តើអ្នក ធ្លាប់ប្រពឹត្តល្មើសនឹងច្បាប់ភ្លើងចរាចរណ៍ (ឧ: នៅតែបន្តដំនើរពេលដែលភ្លើងស្តុបពណ៌លឿងរឺក្រហម) ដែររឺទេ? ❑ មិនធ្លាប់ ❑ ធ្លាប់

12. ជាញឹកញាប់ តើអ្នក ធ្លាប់ប្រពឹត្តល្មើសនឹងច្បាប់ភ្លើងចរាចរណ៍ ប៉ុន្មានដង? (ឧ: នៅតែបន្តដំនើរពេលដែលភ្លើងស្តុបពណ៌លឿងរឺក្រហម)

❑ មិនដែលសោះ ❑ កំរ៉ ❑ ពេលខ្លះ ❑ ញឹកញាប់ ❑ គ្រប់ពេល

សំនួរ	**មិនយល់ស្រប ⟹ យល់ស្រប**				
	1	2	3	4	5
1. ខ្ញុំគិតថា ការនិយាយទូរស័ព្ទពេលកំពុងបើកបរគឺជាឥរិយាបទអាក្រក់ និងគ្រោះថ្នាក់។					
2. ខ្ញុំគិតថា វាជាការប្រថុយប្រថាន និងគ្រោះថ្នាក់ ប្រសិនបើជិះ រឺបើកបរគ្មានពាក់មួកការពារ រឺខ្សែក្រវ៉ាត់ការពារ។					

សំនួរ	មិនយល់ស្រប ⟹ យល់ស្រប				
	1	2	3	4	5
3. ខ្ញុំគិតថា ការបើកបរពេលមានអារម្មណ៍តានតឹង ច្របូកច្របល់ គឺគ្រោះថ្នាក់ និងជាហេតុបង្កអោយមានគ្រោះថ្នាក់ចរាចរណ៍។					
4. ខ្ញុំគិតថា ការបើកបរនៅពេលនឿយហត់ រឹងងុយគេង គឺគ្រោះថ្នាក់ និងជាហេតុបង្កអោយមានគ្រោះថ្នាក់ចរាចរណ៍។					
5. ខ្ញុំគិតថា ការបើកបរថយន្តចាស់ដែលមិនបានត្រួតពិនិត្យត្រឹមត្រូវ គឺគ្រោះថ្នាក់ និងជាហេតុបង្កអោយមានបញ្ហាចរាចរណ៍។					
6. ខ្ញុំគិតថា ការជាកពិន័យអោយធ្ងន់ (ចំពោះ អ្នកមិនពាក់ខ្សែក្រវ៉ាត់ការពារ មួកការពារ និយាយទូរស័ព្ទពេលបើកបរ។ល។) មានសារៈសំខាន់ក្នុងការកាត់បន្ថយគ្រោះថ្នាក់ចរាចរណ៍។					
7. ខ្ញុំគិតថា ការបើបរហូសល្បឿនកំណត់នៅក្នុងទីក្រុង គឺគ្រោះថ្នាក់ និងជាហេតុបង្កអោយមានបញ្ហាចរាចរណ៍។					
8. ខ្ញុំគិតថា ខ្ញុំមិនត្រូវបើកបរក្នុងសភាពងងុយគេង នឿយហត់រឹ នៅពេលមានអារម្មណ៍តានតឹងនោះទេ។					
9. ខ្ញុំគិតថា ខ្ញុំមិនត្រូវទទួលទូរស័ព្ទ រឺប្រើប្រាស់ទូរស័ព្ទ នៅពេលបើកបរនោះទេ។					
10. ខ្ញុំគិតថា វាជាការប្រថុយប្រថាន និងគ្រោះថ្នាក់ណាស់ ប្រសិនបើជក់បារី រឺមើលវីដេអូ នៅពេលបើកបរ។					

សូមអរគុណសំរាប់ការសហការណ៍!!!