Introduction

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 been 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 behavior such as drunk driving, distraction driving, speeding driving, careless driving and other forms of risky driving will be studied.

Research Objectives

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

Dissertation Overview

The dissertation is organized 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’ behavior, application of theory of planned behavior (TPB) and structural equation modelling (SEM) into the travel behavior to investigate the road users’ behavioral intention and drivers’ attitudes toward perceived risk of accident.

Chapter 3, research methodology, describes the theory of planned behavior (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’ behavioral intention toward future urban rail usage and the third questionnaire survey is designed to observe drivers’
attitude toward risky driving behaviors.

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 behavioral 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 behaviors, result of SEM model and the discussion.

Finally, chapter 8, conclusion and recommendations. The overall conclusion, research contributions and recommendations are discussed.

Modelling Structures

This study identifies the latent psychological factor of commuters’ behavioral intention toward future urban rail usage by using three sets of structural equation models. First, we develop the basic model containing only TPB variables. Under this model structure, we hypothesize that the TPB variables, i.e. attitude, subjective norm, and perceived behavioral control, can be applied to predict the behavioral intention towards future urban rail usage.

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.

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.

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.

Numerical Stability in SEM

The problem on numerical analysis and the reference of the diversity of solution in SEM were analyzed 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.

The proposed calculation procedure is summarized into the flow chart (Please check in dissertation for more detail).

Overall Conclusion

This research addresses the latent psychological factors that influence road users’ transportation behavior such as commuters’ behavioral intention, their perception of future urban rail transport, drivers’ perceived risk of traffic accident and their attitudes towards various risky driving behavior 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 behavior (TPB) to investigate road users’ behavioral 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 are revealed. The questionnaire surveys have been done three times: pilot questionnaire survey, main questionnaire surveys for behavioral intention towards future urban rail transport and drivers’ attitudes towards risky driving behaviors.

As for the commuters’ behavioral 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 behavior (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 analyzed using both descriptive statistics and structural equation models in order to discover road users’ behavioral 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 behaviors.

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 behavioral 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 behavioral 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 behavioral intention toward future urban rail usage can be investigated by the theory of planned behavior (TPB) and its extension. The behavioral 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 behavioral 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 behavior. The perceived risk of traffic accident is statistically influenced from drivers’ perception and their attitudes to risky driving behavior 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 behavior. 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 behavior. To the author’s knowledge, this study is the early study regarding the latent psychological factors that could affect the transportation behavior for Cambodians’ drivers and other drivers in developing countries.

**Research Contributions**

The proposed structural models of latent psychological factors of theory of planned behavior (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 analyze the psychological aspects in transportation problems in developing countries based on TPB and SEM.
- Extended of theory of planned behavior (TPB) by to determine the commuter’s behavioral 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 behavioral intention of using future urban rail transit.
- Identified the psychological factors of drivers’ perception toward risky driving behaviors.
- Proposed numerical procedure for the reliability and stability result in structural equation modelling (SEM).
- Can be applied to other ASEAN countries.
- Suggest the countermeasures and strategies base on the results of structural models.