ANALYSIS OF MOTORCYCLE ACCIDENT COST IN THAILAND BY WILLINGNESS-TO-PAY METHOD

Preeda Chaturabong [a], Kunnawee Kanitpong [b], and Piyapong Jiwattanakulpaisarn [c]

[a] School of Engineering and Technology, Transportation Engineering Program, Asian Institute of Technology, Klong Luang, Pathumthani, 12120, Thailand. Email: joauin_sanchez@hotmail.com

[b] School of Engineering and Technology, Transportation Engineering Program, Asian Institute of Technology, Klong Luang, Pathumthani, 12120, Thailand. Email: kanitpon@ait.ac.th

[c] Evaluation Group, Bureau of Planning, Department of Highways, Sri Ayutthaya Road, Ratchathevee District, Bangkok, 10400, Thailand. Email: piyapong.ji@doh.go.th

ABSTRACT

It is well known that the accident costs need to be estimated to understand the existing problem and to perceive a major economic impact of road accident. In addition, the accident cost can be used in the process of road planning and the development of road safety policy. In many developing countries including Thailand, the road accident cost has been traditionally evaluated by the Human Capital Method. This approach, however, has a shortcoming of underestimating the accident cost by the fact that it focuses only on the economic effects of the loss of life and does not account for the value of enjoyment of life forgone. In this study, another alternative method which is the Willingness-To-Pay method (WTP) was selected to evaluate the accident cost. WTP method or the value of risk change is used to estimate the value that individuals would pay for reducing the risk of loss of life. The Contingent Valuation (CV) method is adopted in this study to determine the WTP. In this paper, the cost due to motorcycle accident was focused because the motorcycle crash is the biggest portion among all type of vehicle crashes in Thailand. The questionnaire survey was designed to determine the amount of money that each motorcycle user would pay to reduce the risk of loss of life from motorcycle accident. In this study, a total of 1,015 motorcycle users in Bangkok and surrounding areas were interviewed. The results show that the Value of Statistical Life (VOSL) and the Value of Statistical Injury (VOSI) are in the range of 5.5 to 7 million baht and 2.6-3.4 million baht, respectively. The age, gender, occupation, income, and behavior of helmet use are significant factors affecting the willingness to pay of motorcycle

users to reduce the fatality risk. The age, gender, income, household income, frequency of using motorcycle, accident experience, and the behavior of alcohol-impaired riding are significant factors affecting the willingness to pay of motorcycle riders to reduce the severe injury risk.

1. INTRODUCTION

The economic growth in Thailand has led to an expanding network of roads and increasing number of the vehicles. The growing number of vehicles on the roads has resulted to the significant increase of road crashes in recent years. A total estimated national economic loss due to the road accidents is about 204,000 million Thai baht or 3.1 percent of the GDP in 2005. To address the road safety problem, it is essential to understand accident costs which is related to motivation and awareness. The awareness must be perceived that the problem does exist and also has a major economic impact. It means that if the cost could be visualized in some ways, it would provide motivation to handle the question in an adequate manner, that is, by the provision of the necessary legislation, organization, funding, etc.

Another reason to understand the road accident costs is that the cost of accidents proves to be an important factor in road planning and developing of the road safety policy. To be able to calculate the cost and benefit of different safety measures, it is necessary to know how to quantify and put a value on the effects. The transportation planners have to estimate the cost for improving the infrastructure which is related to the road safety. If the road accident costs are determined, it is possible to make a comparison of the safety benefit with the cost of road safety measure or for the ranking of various measures based on the cost-benefit relationships.

In many developing countries, the road accident cost has been traditionally evaluated by the Human Capital Method. This approach, however, has a weak point of underestimating the accident cost by the fact that it focuses only on the economic effects of the loss of life and does not account for the value of enjoyment of life forgone. Therefore, this method underestimates the actual value of road crashes even though a “pain, grief and suffering” component is sometimes included to represent “human cost”, and increases the value derived. Another alternative method for the evaluation of accident cost is the Willingness-To-Pay method (WTP). This approach has been widely used in many developed countries. WTP method or the value of risk change is used to estimate the value that individuals would pay for reducing the risk of loss of life. This approach is principally based

on survey design to determine the amount of money that individuals would pay to reduce the risk of loss of life.

In Thailand, the statistics shows that motorcycle crash has taken the biggest portion among all type of vehicle crashes as shown in the number of 56% from total of 1,003,890 crashed vehicles. Due to this high proportion of the motorcycle accidents, this study selects the motorcyclists as a target group. Currently, the analysis of the value of life of motorcyclists is not available in Thailand. This study is therefore to estimate the costs of motorcycle accidents in Thailand by using the WTP method. In addition, this study includes the estimation of economic costs of motorcycle crashes by considering the differences in socio-economic characteristics, the attitude towards risk on the value of life, the trip purpose of motorcycle riding, the frequency of trips making by motorcycles. The study also evaluates how these factors affecting the willing to pay of motorcyclists to avoid crash involvement and risk of death.

2. PREVIOUS STUDIES ON ACCIDENT COST ANALYSIS

A number of research studies on the analysis of economic losses due to the road accidents have been conducted in Thailand. Most of these studies have adopted the human capital approach in estimating the accident losses. Research studies in the national level include Patamasiriwat (1994), Tosutho (1997), Boontam (2001), Suwanrada (2005), and Luathep and Tanaboriboon (2005). Studies which are limited to the calculation of road accident losses in Bangkok are Komnamoon (1979) and Promglam (1998). The most recent study conducted to estimate the road accidental loss by using the human capital method was led by Thongchim et al. (2007). In this study, the total losses due to road accidents were reported to be 204,000 million baht throughout 2005. It is reported in this study that the accident cost of individual fatality of Thai people is 4-4.7 million baht, and the accident costs of individual disability and severe injury are 5 million and 0.12 million, respectively.

3. METHODOLOGY

The important subjective elements that should be considered in evaluating the costs of human lives and injuries are “pain, grief and suffering, bereavement”. Many studies have been measuring a value of life, principally for use in the benefit cost analysis. The value of life can be measured in several methods. One of them is the contingent valuation method which was selected to measure the WTP in this study. Contingent Valuation (CV) is a commonly used method for measuring non market values. When CV is compared to

revealed preference market valuation, the advantage of this method is that values can be explained in terms of underlying socio-economic conditions. Potential future events can also be evaluated, in contrast to the retrospective nature of market studies. A CV study of risk reduction should describe the nature of goods to be valued, and provide an evident description of risk and change of risk, and determine a realistic payment. The value of good or service in the CV method is elicited through an elicitation method. In this study, the payment card (PC) was adopted as the CV method to determine the WTP. The PC contains a range of WTP values for the public good under the question where individuals have to choose the maximum values that they are willing to pay.

In this study, the CV questions were designed in two basic forms, open-ended and closed-ended. For the open-ended CV question, the respondent was asked to state the maximum amount at which he or she is willing to pay for the good that is being valued which is the reduction or change of road accidental risk in this study. For the closed-ended CV question, the respondent was asked whether he or she is willing to pay a specified amount presented as the value of the service. For the closed-ended questions, the respondent is supposed to reply “yes” or “no.” Closed-ended questions have been the preferred form of elicitation question since it was introduced by Bishop and Heberlein (1979). In contrast, open-ended questions provide more information than closed-ended questions; and do not require econometric modeling to analyze, as the mean WTP values of respondents can be readily estimated by simple arithmetic calculation.

3.1 Questionnaire Design

The designed questionnaires include the questions which were separated into three sections. The questions in the first section are related to the socioeconomic characteristics and household characteristics of the respondents. The second section includes the questions related to the riding behavior and the risk-taking behaviors of motorcycle users such as frequency of using motorcycle, helmet use, riding against traffic (counter-flow riding), speeding, experience of involving in the accident, and alcohol-impaired riding. The last section of the questionnaire includes the valuation questions which were designed to ask the respondents to provide the estimates of the relevant rates that they are willing to pay for a reduction in the probability of fatality and injury due to the motorcycle accidents.

The valuation questions were presented in two scenarios. Each scenario was filled out as two elicitations which are the open-ended and closed-ended method. The first scenario is to evaluate the WTP of respondents in their own risk of death, and the second

scenario is to evaluate the WTP to reduce the risk of severe injury. For the closed-ended question (also referred to as a "dichotomous choice" or "referendum" question), the respondent is asked whether he or she is willing to pay a specified amount presented as the value of the risk reduction. The respondent is expected to answer "yes" or "no." The closed-ended questions have been the preferred form of elicitation question since it was introduced by Bishop and Heberlein (1979). For the opened-ended question, the respondents were asked to state the maximum amount that he or she is willing to pay for the good that is being valued.

3.1.1 First Scenario: Risk of Fatality

In the first scenario, the respondents were asked to imagine that he/she needs to take a bus to go to Khonkaen province. The cost of the bus fare depends on condition of bus and driver in terms of safety. It is assumed that for Bus A the cost of travelling to Khonkaen is 250 baht per trip, the probability of dead due to the road accident while travelling on this bus is 16/100,000 each year. In the closed-ended question, the respondent was asked for the first question that *"Are you willing to pay 400 baht per trip to take Bus B to Khonkaen which can reduce the fatality risk from 16 to 8 deaths in every 100,000 people or 50% reduction in fatality risk?"* The respondent was supposed to answer "yes" or no", and the second question was asked that *"If the fare for Bus B is increased to 500 baht per trip, are you willing to pay?",* and then followed by the third question to increase the bus fare to 1,000 baht per trip. If the respondent answers "no" in the second question, the third question will not be asked. In the open-ended question, the respondent was simply asked that *"How much are you willing to pay for taking Bus B to Khonkaen to avoid fatality risk to reduce from 16 to 8 deaths in every 100,000 people or 50% reduction in fatality risk?".*

3.1.2 Second Scenario: Risk of Severe Injury

In the second scenario, the respondents were asked to imagine that he/she has to wear the helmet while riding motorcycle. The respondent has two options for selecting different helmet type. The sample of the question is that for Helmet A, the cost of helmet is 500 baht per helmet, the probability to have severe injury due to the motorcycle accident is 26/100,000 each year.

In the closed-ended question, the respondent was asked for the first question that *"Are you willing to pay 600 baht to buy Helmet B which can reduce the risk of severe injury from 26 to 13 severe injured people in every 100,000 people?"* The respondent was

supposed to answer "yes" or no", and the second question was asked that *"Are you willing to pay for Helmet B, if the price is increased to 1,000 baht?"* If the respondent answers "no" in the first question, the second question will not be asked. In the open-ended question, the respondent was simply asked that *"How much are you willing to pay for Helmet B to reduce the risk of severe injuries due to motorcycle accident from 26 to 13 severe injured people in every 100,000 people?"*

3.2 Data Collection

A total of 1,015 respondents were interviewed for the data collection in this study. The respondents are the motorcycle users who live in Bangkok and suburb areas such as Nonthaburi, Pathumtani, Samutprakarn, and Nakornpathom. The interview was conducted at several locations such as government offices, private companies, schools and universities, markets, and on public streets, and etc. Respondents were randomly selected from different days of week, time of the day, places in each province and characteristics of drivers (gender, age, family status, occupation, education, monthly income, and household income). Table 1 and Table 2 describe socio-economic characteristics, riding behavior and the risk-taking behaviors of the respondents, respectively.

Table 1 - Socio-Economic Characteristics of Respondents

Socio-Economic Characteristics		**Frequency**	**Percent**
Gender	Female	385	37.9
	Male	630	62.1
	Total	1,015	100
Age	< 21	180	17.7
	21-30	450	44.3
	> 30	385	38.0
	Total	1,015	100
Family Status	Single	606	59.7
	Married	409	40.3
	Total	1,015	100
Education	Uneducated	12	1.2
	Elementary School	84	8.3
	Secondary School	293	28.9
	Diploma	179	17.6
	Bachelor Degree	415	40.9
	Higher than Bachelor Degree	32	3.2
	Total	1,015	100
Occupation	Government Officer	136	13.4
	Private Employee	219	21.6
	Own Business	140	13.8
	Labor	220	21.7
	Student	256	25.2
	Housewife	35	3.4
	Others	9	0.9
	Total	1,015	100
Monthly Income (Baht)	<= 5,000	190	18.7
	5,001-10,000	395	38.9
	10,001-20,000	276	27.2
	20,001-30,000	99	9.8
	30,001-40,000	38	3.7
	>40,000	17	1.7
	Total	1,015	100
Household Income (Baht)	<= 5,000	32	3.2
	5,001-10,000	201	19.8
	10,001-20,000	228	22.5
	20,001-30,000	230	22.7
	30,001-40,000	166	16.4
	>40,000	158	15.6
	Total	1,015	100
No. of Household	Less than 5	650	64.0
	More than 5	365	36.0
	Total	1,015	100

Table 2 – Riding Behaviors of Respondents

Riding Behaviors		**Frequency**	**Percent**
Frequency of using motorcycle in a week	< 1 day	197	19.4
	1-2 days	158	15.6
	Almost everyday	264	26.0
	Everyday	396	39.0
	Total	1,015	100
Helmet use	All times	402	39.6
	Often	261	25.7
	Seldom	300	29.6
	Never	52	5.1
	Total	1,015	100
Riding against traffic (counter-flow riding)	Often	76	7.5
	Moderate	159	15.7
	Seldom	516	50.8
	Never	264	26.0
	Total	1,015	100
Speeding	< 50 km/h	224	22.1
	51-70 km/h	504	49.7
	71-90 km/h	245	24.1
	> 90 km/h	42	4.1
	Total	1,015	100
Experience of involving in the accident	Yes	552	54.4
	No	463	45.6
	Total	1,015	100
Alcohol-impaired riding	Very often	19	1.9
	Often	85	8.4
	Seldom	426	42.0
	Never	485	47.8
	Total	1,015	100

3.3 Methodology for Accident Cost Analysis

For the open-ended questions, the mean WTP values of respondents can be estimated by simple arithmetic. For the closed-ended questions, the mean WTP values can be estimated by using econometric models which is the probit regression technique (Hanemann 1984). In this study, the concept of statistical life is applied to determine the Value of Statistical Life (VOSL) and the Value of Statistical Injury (VOSI). VOSL and VOSI are the total willingness to pay to avoid an expected occurrence of one fatality or injury, if each person in the population of 1 million is willing to pay a specified amount of money to avoid a risk of 10^{-6}. VOSL or VOSI is usually expressed as willingness to pay for a change in risk divided by the change in risk.

VOSL or VOSI = mean WTP / change in risk for fatality or injury

The probability of risk of motorcycle users in Bangkok and surrounding areas can be explained based on the following decision tree as shown in Figure 1.

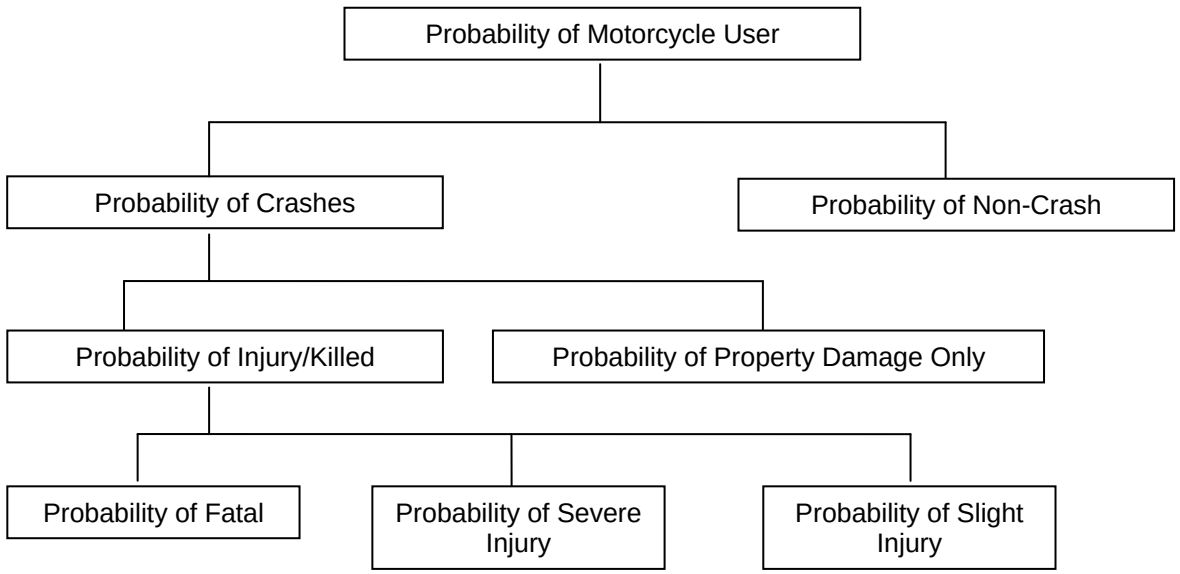

Figure 1- Event Tree for Motorcycle Crashes and Injuries

To calculate the risk of fatality or injury due to motorcycle crash, the risk proportion was analyzed from the probability of motorcycle crashes in Bangkok and surrounding areas. The fatality risk or injury risk were determined based on the event tree in Figure 1 and can be calculated by using the following equation.

Fatality risk = Prob. Crashes × Prob. Injury/Killed × Prob. Fatal

Severe Injury risk = Prob. Crashes × Prob. Injury/Killed × Prob. Severe Injury

The change in risk was then calculated by taking the percentage of risk reduction multiplied by each type of risk. The calculation of fatality risk and severe injury risk for the motorcycle accident was illustrated in Table 3.

Table 3 - Probability and Risk of Motorcycle Users

Number/Popability	Bangkok	Pathum Thani	Nonthaburi	Samut Prakarn	Nakhon Pathom	Total
Number of motorcycles	2339308	40071	40502	37751	205188	2662820
Number of people involved	2573239	44078	44552	41526	225707	2929102
Number of Fatality	240	75	49	68	72	504
Number of severe injuries	507	54	70	66	88	785
Motorcycle accidents	20999	219	1204	2202	578	25202
Probability of crash	0.00860					
Probability of injured/fatal	0.39798					
Probability of fatal	0.05025					
Probability of severe injury	0.07827					

Risk	
	0.0001721
	0.0002680

4. ANALYSIS OF ACCIDENT COST

The mean values of WTP were determined from the open-ended and closed-ended methods by using the methodology as described in Section 3. The mean values of WTP from both methods were summarized in Table 4.

Table 4 - Mean Values of WTP

Willingness To Pay (baht)		
Risk Type	**Closed-Ended**	**Open-Ended**
Fatality	815	695
Severe Injury	945	841

Note Starting point for fatality = 250 baht
Starting point for severe injury = 500 baht

4.1 WTP to Reduce the Risk of Fatality

The valuation questions of the closed-ended method were to assume the situation whether the respondent is willing to pay more for reducing the risk of fatality. The dichotomous choice was applied to ask for the answer of respondents. The question literally contains 3 questions, and also 2 alternative choices to choose the answer “Yes” or “No”. As shown in Table 4, the WTP obtained from the closed-ended method gives a value of 815 baht to reduce the risk of fatality. In the questionnaires, the open-ended question was also included to determine the maximum amount of paying to reduce the risk of fatality that the respondent is willing to pay. As shown in Table 4, the maximum amount of WTP to reduce fatality risk is 695 baht.

4.2 WTP to Reduce the Risk of Severe Injury

Another valuation question of the closed-ended method was designed to assume the situation whether the respondent is willing to pay more for reducing the risk of severe injury. The dichotomous choice was also applied to ask for the answer of respondents. In Table 4, the WTP obtained from the closed-ended questionnaire gives a value of 945 baht to reduce the risk of severe injury. For the open-ended method, a similar question was asked for the maximum paying amount to reduce the risk of severe injury. The maximum amount of WTP to reduce severe injury risk is 841 baht as summarized in Table 4.

4.3 Mean WTP for Risk Reduction

Table 5 shows the expected value which is the net willingness to pay to avoid any fatality and injury risk due to the motorcycle accident. This value can be applied in a benefit-cost analysis for a road project that would be expected to reduce a certain number of injury-accidents. In order to calculate the value of life, the net willingness to pay to reduce the risk

must be perceived. Therefore, the WTP of respondents was subtracted by the starting point setting up as a baseline for WTP. The mean WTP for risk reduction was then calculated as shown in Table 5.

Table 5 - WTP for Risk Reduction

Willingness To Pay for Risk Reduction (baht)		
Injury Type	**Closed-Ended**	**Open-Ended**
Fatality	565	445
Severe Injury	445	341

4.4 Value of Statistical Life and Injury (VOSL and VOSI)

Table 6 shows VOSL and VOSI calculated based on the WTP. The VOSL and VOSI were calculated by dividing the mean WTP for risk reduction by the change in risk. The VOSL and VOSI are the net willingness to pay by the individual to avoid one occurrence of the indicated injury type. The estimates of VOSL and VOSI were computed from the responses of the two valuation questions (closed-ended and open-ended methods).

Table 6 - Value of Statistical Life and Injury (VOSL and VOSI)

VOSL and VOSI (baht)		
Injury Type	**Closed-Ended**	**Open-Ended**
VOSL(Fatality)	7,063,625	5,560,739
VOSI(Severe Injury)	3,425,077	2,622,205

5. ANALYSIS OF FACTORS INFLUENCING WTP

This section is to evaluate the factors affecting the willingness to pay of motorcyclists to avoid crash involvement and risk of death. In this study, the logistic regression model was applied to analyze the significant factors influencing willingness to pay of respondents in the closed-ended method, while the linear regression model was applied in the open-ended method. The independent variables considered in the analysis include socio-economic characteristics of the respondents, such as gender, age, status, occupation, education, income, household income, and number of households, and riding behavior such as frequency of using motorcycle, helmet use, riding against traffic, speeding, experience of

involving in the accident, and alcohol-impaired riding. Table 7 shows the definitions of the independent variables remaining in the analysis.

Table 7 - Definitions of Independent Variables

Variables	Definition
AGE	Age (Continuous variable)
GENDER	Gender (1 if male, 0 otherwise)
FAMILY	Family Status (1 if single, 0 otherwise)
EDUCATE	Education (1 if college level, 0 otherwise)
OCCUP1	Government Officer (1 if government officer, 0 otherwise)
OCCUP2	Private Employee (1 if private employee, 0 otherwise)
OCCUP3	Student (1 if student, 0 otherwise)
INCOME1	Income level 1 (1 if income < 10,000 baht, 0 otherwise)
INCOME2	Income level 2 (1 if income = 10,001-20,000 baht, 0 otherwise)
INCOME3	Income level 3 (1 if income > 20,000 baht, 0 otherwise)
INCOMEh1	Household Income 1(1 if household income < 20,000 baht, 0 otherwise)
INCOMEh2	Household Income 2(1 if household income = 20,001-40,000 baht, 0 otherwise)
INCOMEh3	Household Income 1(1 if household income > 40,000 baht, 0 otherwise)
HOUSEHOLD NO.	Number of household (Continuous variable)
RIDING FREQ	Frequency of Using Motorcycle (1 if often riding motorcycle, 0 otherwise)
HELMET	Helmet Use (1 if often using helmet, 0 otherwise)
AGAINST TRAFF	Riding Against Traffic (1 if often riding against traffic, 0 otherwise)
SPEEDING	Speeding (1 if riding > 70 km/h, 0 otherwise)
ACCI EXP	Accident Experience (1 if having accident at least 1 or more, 0 otherwise)
ALCOHOL	Alcohol-Impaired Riding (1 if often alcohol-impaired riding, 0 otherwise)

Table 8 and Table 9 present estimation results from the logistic models for WTP to reduce fatality and injury risks based on the closed-ended method, and the linear regression models for WTP to reduce fatality and injury risks based on the open-ended method. The relative magnitude of estimated coefficients indicates the extent to which socio-economic characteristics and riding behaviors affect the WTP for the risk reduction due to the motorcycle accident.

Model 1 and Model 2 were used to evaluate the significant factors influencing the WTP to reduce fatality risk of motorcycle accident. The dependent variable in Model 1 is the answer made by the respondents whether he or she is willing to pay a specified amount presented as the value of the risk reduction. The dependent variable in Model 2 is the

amount of money that the respondents are willing to pay to reduce the fatality risk of motorcycle accident. The results of regression analysis of Model 1 and 2 were presented in Table 8. It is evident from the model that the significant factors influencing WTP to reduce fatality risk of motorcycle accident are age, occupation, income, and helmet use for the closed-ended method, and gender and helmet use for the opened-end method. The coefficients of these variables are statistically significant at 1-10% level; however, the signs are varied depending on the effect of each variable.

In Model 1, age is a significant factor affecting WTP to reduce fatality risk. The negative sign suggests that younger respondents are more likely to be willing to pay when comparing to older respondents. The positive sign associated with the coefficients of the occupation suggests that government officer is more likely to pay more than the students to reduce the fatality risk due to motorcycle accident. The estimated coefficients for income are significant with negative signs. It can be explained that the respondents with lower income are less willing to pay than those with higher income. Lastly, the helmet use is another significant factor affecting the WTP as shown in Model 1. The positive sign indicates that the respondents who always use helmet are more likely to be willing to pay to avoid fatality risk.

Table 8 - Regression Models for WTP to Reduce Fatality Risk

Variables	**WTP to Reduce Fatality Risk**					
	Model 1: Closed-End			**Model 2: Opened-End**		
	Coeff.	**t**	**P>t**	**Coeff.**	**t**	**P>t**
AGE	**-0.0119****	-1.97	0.049	-1.659	-1.21	0.225
GENDER	-0.148**	-1.96	0.049	**-34.123***	-1.87	0.062
FAMILY	-0.057	-1.29	0.199	-2.385	-0.29	0.771
EDUCATE	0.009	0.11	0.913	21.413	1.2	0.229
OCCUP1	**0.397****	2.09	0.036	16.370	0.39	0.699
OCCUP2	0.023	0.17	0.867	6.512	0.21	0.836
INCOME1	**-0.512*****	-2.66	0.008	-63.460	-1.51	0.132
INCOME2	**-0.361****	-2.01	0.044	-36.147	-0.92	0.358
INCOMEh1	0.038	0.21	0.836	-21.098	-0.51	0.607
INCOMEh2	-0.118	-0.72	0.469	-37.044	-1.02	0.309
HOUSEHOLD NO.	0.029	1.01	0.311	-3.188	-0.51	0.611
RIDING FREQ	0.016	0.13	0.894	-21.108	-0.76	0.445
HELMET	**0.217*****	1.87	0.062	**45.472***	1.72	0.085
AGAINST TRAFF	-0.110	-0.87	0.383	6.349	0.22	0.824
SPEEDING	0.124	1.01	0.314	36.616	1.33	0.183

ACCI EXP	-0.128	-1.16	0.245	-25.912	-1.05	0.294
ALCOHOL	-0.096	-0.82	0.414	-2.984	-0.11	0.91
Constant	3.857	11.87	0	821.201	11.96	0
No. of observation	1015			1015		

Note: *** indicates significance at the 1% level.
** indicates significance at the 5% level.
* indicates significance at the 10% level.

In Model 2, gender and helmet use are only two factors significantly affecting the WTP to reduce fatality risk. The negative sign of the coefficient of gender suggests that male respondents are less willing to pay when comparing to female respondents. Similar to the result obtained from Model 1, the positive sign of helmet use variable indicates that respondents who often use helmet are more likely to be willing to pay to avoid the fatality risk.

Model 3 and Model 4 were analyzed to evaluate the significant factors influencing the WTP to reduce severe injury risk of motorcycle accident. The regression analysis results of Model 3 and 4 were presented in Table 9. Model 3 and 4 are the results of analysis of the closed-ended and open-ended methods, respectively.

In Model 3, gender, income, household income, frequency of using motorcycle, accident experience, and alcohol-impaired riding significantly affect the WTP to reduce the risk of severe injury. It was found that male respondents tend to have less willing to pay than female respondents. The negative coefficients for income1 and income2 variables show that the respondents with lower income tend to have less willing to pay to reduce the risk of severe injury than those with higher income. Similarly, the respondents whose household income is lower tend to have less willing to pay than those whose household income is higher. Respondents who often use the motorcycle are less likely to be willing to pay for the risk reduction. The accident experience also shows the significant effect to the WTP as shown that the respondents who have been involved in a road-traffic accident are less likely to pay when comparing to those who have never had accident experience. For the alcohol-impaired riding, the coefficient with negative sign indicates that respondents with alcohol-impaired while driving are less likely to be willing to pay to avoid the severe injury risk.

In Model 4, age, gender, income, household income, speeding, accident experience, and alcohol-impaired riding significantly affect the WTP to reduce the risk of severe injury. The trends of the results in Model 4 are similar to the results interpreted in Model 3, especially for the gender, income, household income, accident experience, and alcohol-

impaired riding. For the speeding, the coefficient with positive sign indicates that the respondents who often ride with higher speed of greater than 70 km/h are more willing to pay than those who rarely ride motorcycle with that high speed. It was also found that younger motorcycle users are more willing to pay than older motorcycle users.

Table 9 - Regression Models for WTP to Reduce Severe Injury Risk

Variables	WTP to Reduce Severe Injury Risk					
	Model 3: Closed-End			Model 4: Opened-End		
	Coeff.	t	P>t	Coeff.	t	P>t
AGE	-0.003	-0.4	0.688	**-1.965***	-1.8	0.073
GENDER	**-0.179****	-2.07	0.038	**-28.737****	-1.98	0.048
FAMILY	-0.028	-0.59	0.557	-5.842	-0.7	0.484
EDUCATE	0.075	0.89	0.374	22.439	1.58	0.114
OCCUP1	0.293	1.43	0.152	14.097	0.42	0.675
OCCUP2	-0.234	-1.57	0.116	-39.780	-1.58	0.114
INCOME1	**-0.607*****	-2.91	0.004	**-102.046*****	-2.98	0.003
INCOME2	**-0.496****	-2.55	0.011	**-59.944***	-1.88	0.06
INCOMEh1	-0.195	-0.97	0.33	**-60.549***	-1.84	0.066
INCOMEh2	**-0.451****	-2.52	0.012	**-83.172*****	-2.85	0.004
HOUSEHOLD NO.	-0.012	-0.41	0.683	3.225	0.63	0.528
RIDING FREQ	**-0.230***	-1.74	0.082	-11.486	-0.52	0.603
HELMET	-0.048	-0.38	0.702	-4.819	-0.23	0.819
AGAINST TRAFF	0.038	0.28	0.777	9.472	0.41	0.68
SPEEDING	0.187	1.42	0.154	**44.484****	2	0.046
ACCI EXP	**-0.236****	-2	0.046	**-32.663***	-1.65	0.1
ALCOHOL	**-0.330*****	-2.61	0.009	**-38.795***	-1.82	0.069
Constant	3.923	10.84	0	1086.552	19.7	0
No. of observation	1015			1015		

Note: *** indicates significance at the 1% level.
** indicates significance at the 5% level.

6. SUMMARY OF FINDINGS

This paper is to estimate the costs of motorcycle accidents in Thailand by using the Willingness-to-Pay method. This study also evaluate how the differences in socio-economic characteristics and riding and risk-taking behaviors affecting the willingness to pay of motorcycle users to avoid crash involvement and risk of death. The study was separated

into two parts, the motorcycle accident cost analysis and the analysis of factors affecting the WTP. The questionnaire survey was conducted in Bangkok and surrounding areas such as Nonthaburi, Pathumtani, Samutprakarn, and Nakornpathom. A total of 1,015 motorcycle users were interviewed by using the questionnaires designed based on the Contingent Valuation (CV) method. The designed questionnaires include the questions which were separated into three sections, the socioeconomic characteristic questions, the riding behavior questions, and the valuation questions. The valuation questions were designed in two basic forms, open-ended and closed-ended questions.

In the first part, the motorcycle accident cost was analyzed by using the concept of statistical life. The Value of Statistical Life (VOSL) and the Value of Statistical Injury (VOSI) were determined for the motorcycle users. It was found that the VOSL calculated from this study is in the range of 5.5 to 7 million baht, and the VOSI is in the range of 2.6-3.4 million baht. The estimated value of life in this study is considerably higher than the value calculated in previous studies conducted by Thongchim (2007) and Suwanrada (2005). The result can be explained that different methods were applied in the calculation of the accident cost, and the target group was differently focused in this study.

In the second part, the significant factors affecting the willingness to pay of motorcycle users to reduce the risk of death and injury were evaluated. It seems that the respondents with different socioeconomic characteristics and different riding behaviors express their willingness to pay for the risk reduction differently. The regression model reveals that older people and male riders show less willingness to pay to reduce the fatality risk. Government officers tend to pay more to reduce their risk to face the fatal motorcycle accident. It is apparent to see that the motorcycle riders with lower income have less willingness to pay to save their lives from the accident. This is what has been expected since lower income people may have the financial constraint in paying for some money values to reduce the accidental risk. However, it is interesting to find that people who often use the helmet show more willingness to pay for the fatal risk reduction.

To reduce the risk of injury, age, gender, income, household income, frequency of using motorcycle, accident experience, and alcohol-impaired riding significantly affect the willingness to pay. The trends of age, gender, and income are similar to the results found from the analysis of WTO to reduce the fatality risk. In addition, it was found that people who always use the motorcycle, those who have had accident experience, and those who often impaired by alcohol consumption while riding are not willing to pay more to reduce their severe injury risk. Surprisingly, the motorcycle users who always ride motorcycle with higher speed tend to have more willingness to pay for saving their lives from the accident.

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