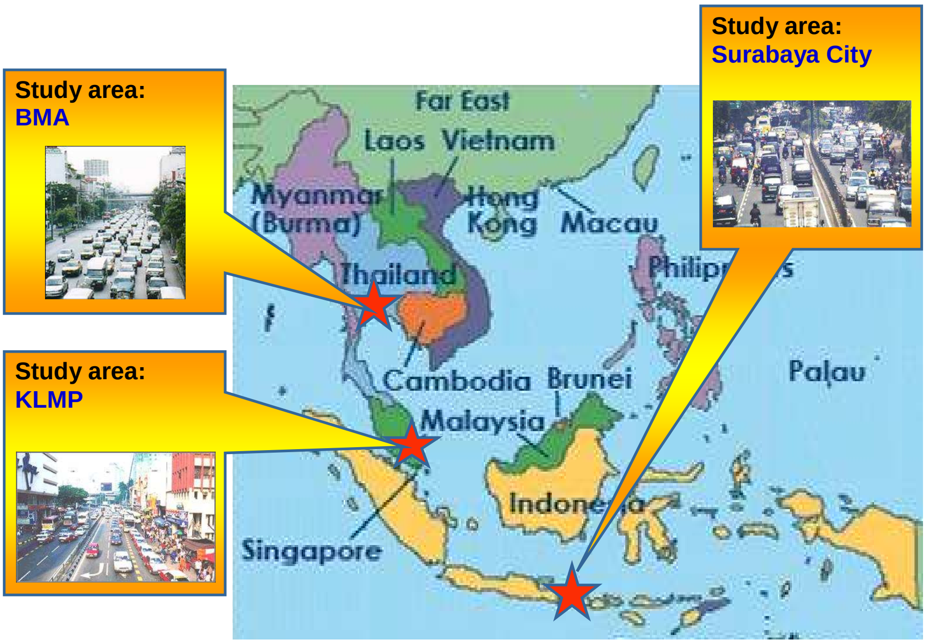
Inter-regional Valuation of Road Casualties and Exploration of Social Attitudes to Road Casualty Reduction in Southeast Asian Countries, Thailand, Malaysia and Indonesia

Valuing Road Casualties using Willingness-to-Pay Discrete Choice Approach



ICRA Final Report (2005-07)

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Principal Researcher: Dr Dilum Dissanayake (Newcastle University, UK)

Co-researchers:
Professor Radin S. Radin Umar (MIROS, Malaysia)
Assoc. Professor Mohd Faudzi (MIROS, Malaysia)
SN Bentotage (Manchester University, UK)
Hera Widyastuti (Institut Teknologi Bandung, Indonesia)
Wahju Herijanto (Institut Teknologi Bandung, Indonesia)

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SUMMARY

Improving transport safety in general and reducing road casualties in particular have been receiving more attention in Asia in recent years due to the ever increasing number of deaths and casualties. Undoubtedly the reduction of road deaths and casualties consumes considerable financial resources. In order to justify the resource requirements for promoting and implementing road safety programs and to evaluate the proposed road safety regulations in Asian cities, it is crucial to determine the cost of road casualties and the value of preventing them. Valuation of road casualties is achievable using various techniques available. The cost of casualties is generally affected by the valuation techniques utilised. However, the appropriate technique for any particular prospect may depend on its own objectives and priorities. The valuation of road accidents are targeted at either the maximisation of national output or the fortification of social welfare objectives.

At present, Asian countries remain far behind developed countries in terms of the utilization of valuation methods that fulfil social welfare objectives. The traditional gross output method has been employed for the valuation of road safety in Asia for several decades even though it has some inconsistencies in terms of welfare economics. Additionally, the gross output method disregards some important aspects that may lead to substantial resource misallocation. In contrast, *the Willingness-to-pay* (WTP) method, which meets the welfare objectives and cost-benefit analysis, is widely tested in developed countries.

This project applies the WTP method for valuing road casualties in Southeast Asian countries as a methodology transfer attempt. The case study cities selected for this project are the Bangkok Metropolitan Area (Thailand), Kuala Lumpur Metropolitan (Malaysia), and Surabaya city (Indonesia). This research identifies that *the State-of-the-art Discrete Choice Modelling Technique* is an appropriate tool to model the WTP and to investigate social attitudes to road casualty reduction. Accordingly Multinomial Logit (MNL) Models were developed to examine the way that peoples' socio-economic status and past casualty experiences link to their WTP choices. The developed MNL models were then used to estimate *the Value of Statistical Life* (*VSL).* The lives that saved by safety improvements cannot be identified in advance. Therefore, the concept of statistical life is used in this study to measure the value of reducing risks in society.

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1. INTRODUCTION

1.1 Rationale

The unprecedented demand for travel experienced in Asia, in conjunction with the economic development of the 1980s, has resulted in a number of detrimental effects on urban systems. The economic development has certainly intensified per capita income enhancing personal mobility. In Asia, private vehicle ownership and usage have continued to be recognized as an essential element of travel for many. Motorisation brings many inexperienced drivers onto the roads, escalating deaths and injuries from road traffic accidents. In a vehicle-dominant road network, pedestrians and cyclists are at particular risk so improving their safety will be an important issue.

Improving transport safety in general and reducing road casualties in particular have been receiving more attention in Asia in recent years due to the ever increasing number of deaths and casualties. Many organisations including the World Health Organisation (WHO) [1999], the Asian Development Bank (ADB) [1997], the Transport Research Laboratory (TRL) [2003], and the Global Road Safety Partnership (GRSP) [2005] have identified the importance of improving road safety, especially in Asian countries. As reported by GRSP [2005], 44% of the global road traffic fatalities in 1999 happened in Asia and the Pacific regions (see Figure 1).

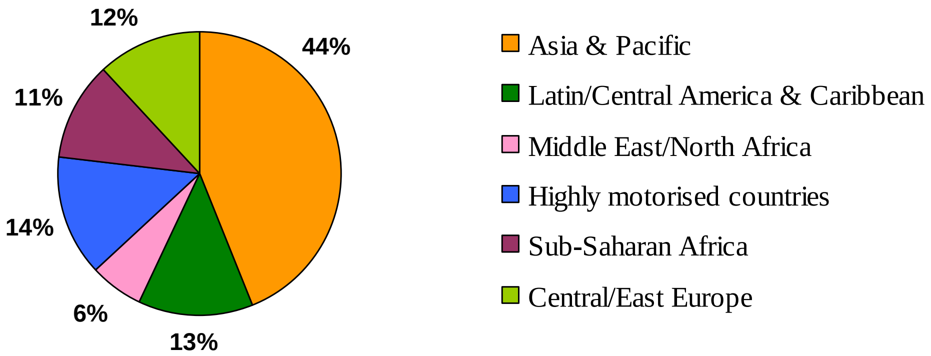


Fig. 1 Regional Distribution of Road Traffic Fatalities in 1999
Data Source: GRSP [2005]

Undoubtedly the reduction of road deaths and casualties consumes considerable financial resources. Bearing many problems to alleviate with prioritised funding, most of the Asian countries do not have sufficient funds for road safety enhancements. In order to justify the resource requirements for promoting and implementing road safety programs and to evaluate the proposed road safety regulations in Asian cities, it is crucial to determine the cost of road casualties and the value of preventing them. Valuation of road casualties is achievable using various techniques available. The cost of casualties is generally affected by the valuation techniques utilised. However, the appropriate technique for any particular prospect may depend on its own objectives and priorities. The valuation of road accidents are targeted at either the maximisation of national output or the fortification of social welfare objectives.

The following valuation methods have direct relevance to the above targets:

- Gross (Net)-output or human capital (HC) method [maximise the wealth of a country]
- Willingness-to-pay (WTP) method [maximise social welfare and cost-benefit factor]

At present, Asian countries remain far behind developed countries in terms of the utilization of valuation methods that fulfil the social welfare objectives. The traditional gross (net)-output method has been employed for the valuation of road safety in Asia for several decades even though it has some inconsistencies in terms of welfare economics [Fauzi et al., 2004]. Additionally, the gross (net)-output method disregards some important aspects that may lead to substantial resource misallocation [Miller, 1996; Rice and MacKenzie, 1989]. In contrast, the WTP method, which meets social welfare objectives, is widely tested in developed countries. A recent study by Fauzi et al. [2004] is a pioneering attempt to utilize the WTP method for the costing of motorcycle accidents in Malaysia.

In this project, the WTP valuation method for valuing road casualties, which has been tested in developed countries, is applied in Southeast Asian countries as a methodology transfer attempt. The case study cities selected for this project are the Bangkok Metropolitan Area (Thailand), Kuala Lumpur Metropolitan (Malaysia), and Surabaya city (Indonesia). This research identifies that *the State-of-the-art Discrete Choice Modelling Technique* is an appropriate tool to investigate social attitudes to road safety improvements and to analyse their WTP for individual, household, and community risk reduction. There are four severity classes (SC) considered for the analysis:

- SC1- Slight casualty,
- SC2- Serious casualty but no permanent disability,
- SC3- Serious casualty with permanent disability, and
- SC4- Fatal casualty.

To carry out inter-regional valuation of road safety in three Southeast Asian cities, the Multinomial Logit (MNL) Model that comes under *Discrete Choice Techniques* is found to be an analytically convenient modelling method. For each case study city, eight MNL models are developed in which four of them are for car casualties (C-SC1, C-SC2, C-SC3, and C-SC4) and the others are for motorcycle casualties (MC-SC1, MC-SC2, MC-SC3, and MC-SC4). The *Value of Statistical Life* (*VSL*) is estimated for both car and motorcycle casualties over all severity classes.

1.2 Aims and Objectives

The aim of this research project is to apply *the State-of-the-art Discrete Choice Modelling Technique* to investigate social attitudes to road safety improvements and to value car and motorcycle casualties in Southeast Asian countries giving attention to Bangkok, Kuala Lumpur, and Surabaya as case study cities.

The specific objectives are:

- Review available techniques on road safety valuation in both developed and developing countries to elaborate research gaps and formulate research questions
- Design and carry out a questionnaire survey to collect data on WTP for road casualty reduction in Southeast Asian cities, and prepare the data to underpin the analysis
- Develop MNL models for the case study cities and analyse WTP data taking into consideration each severity class
- Investigate social attitudes to road safety improvement and to the reduction of road casualty risk, and
- Apply the developed MNL models to estimate *the Value of Statistical Life* (*VSL*) of road casualties

1.3 Methodology in Brief

The project is conducted in five stages. Stage I will focus on an in-depth review of safety valuation, valuation techniques, and social attitudes to road safety as well as risk reduction. Development of data sources is achieved in Stage II. The tasks including data modelling and analysis are accomplished in Stage III. Safety valuation is conduced in Stage VI. The outcome of the project and the potential future directions of this project are discussed in stage V.

2. ROAD CASUALTIES IN ASIA

2.1 Fatality Risk and its Relationship with the Level of Motorisation

As reported by GRSP [2005], road casualties are exceptionally high in the Asian and Pacific Region with 44% of the world's road fatalities. According to Figure 2, highly motorised countries including Malaysia, Thailand, and Korea are responsible for a significant share of the road fatalities with a fatality risk about 5 times that of China and India. Bangladesh, which has the lowest motorisation level among other Asian countries, apparently has the lowest fatality risk. Malaysia is found to have the highest fatality risk in the world as explained by GRSP [2005].

Major changes have happened in Asia within the past few years. Motorisation has grown at an increasing rate, largely with the growth in motorcycles [GRSP, 2005]. The number of motor vehicles has been nearly trebled in China and more than doubled in the other large Asian countries in less than a decade. Fatality risk appears to increase with motorisation in Asian countries (figure 2).

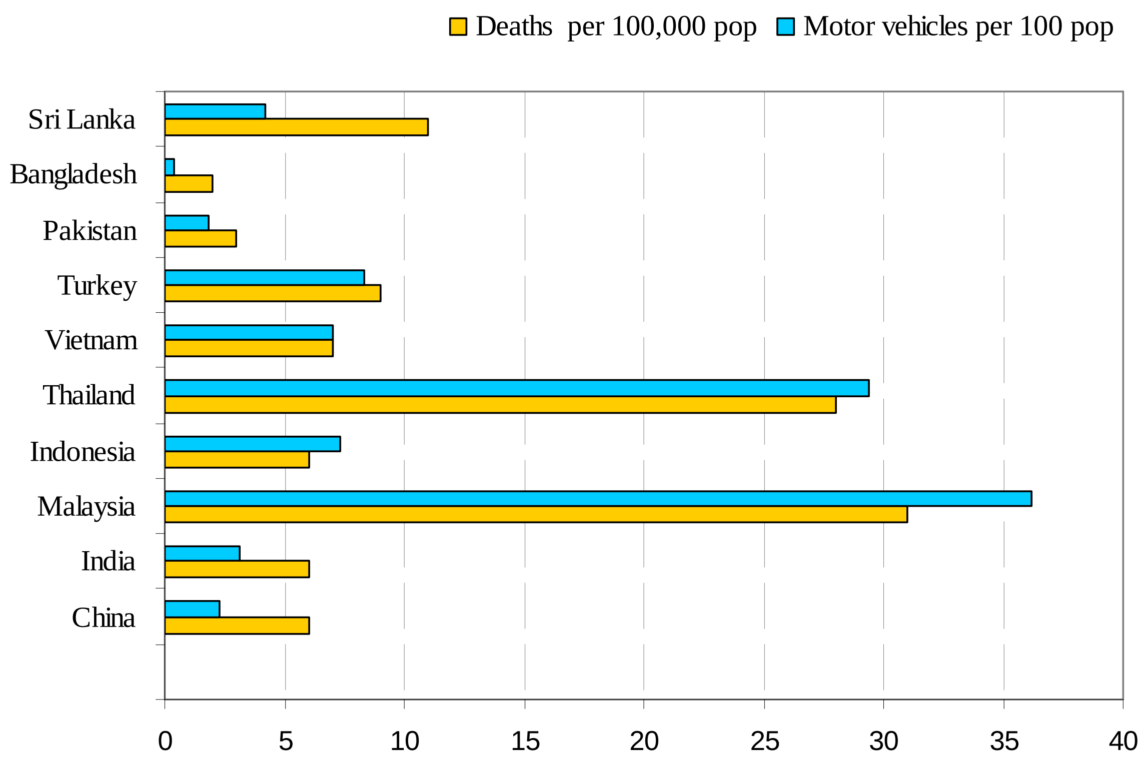


Fig. 2 Comparison Between Fatality Risk and Motor Vehicle Usage in Asian Countries 1996
Data Source: GRSP [2005]

Even though population growth in China has been maintained at less than 10% a year, road deaths have increased by 40%. The high economic growth and the increasing vehicle ownership levels there in the past decade can be identified as the reason for mounting road deaths. Accordingly the personal risk of being killed in a road crash has more than quadrupled in China.

2.2 Vulnerable Road Users

Vulnerable road users (VRU), for example pedestrians, motorcyclists, and cyclists, are a particularly high-risk group throughout Africa and Asia as well as the Middle East region [GRSP, 2005]. Figure 3 below represents the casualty distribution of VRU in selected Asian cities. In both Sri Lanka and Hong Kong, pedestrians are more open to becoming casualties. In particular, the motorcycle is not a popular mode for many in Sri Lanka and therefore the level of involvement of motorcyclists in accidents is comparatively low. In contrast, the crash distribution of VRU in Malaysia, Taiwan, and Singapore is dominated by motorcycle related casualties.

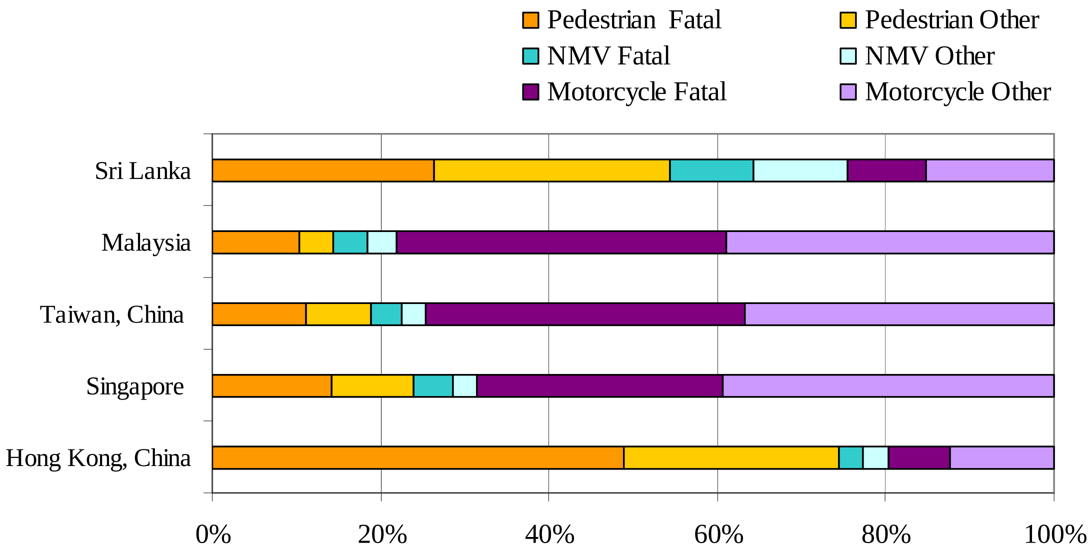


Fig. 3 Casualty Distribution by Vulnerable Road Users in Selected Asian Cities
Data Source: GRSP [2005]

3. CASE STUDY AREAS

3.1 General

The case study cities selected for this project are the Bangkok Metropolitan Area (Thailand), Kuala Lumpur Metropolitan (Malaysia), and Surabaya city (Indonesia) (see figure 4 below)

Fig. 4 Case Study Areas

Bangkok, the capital of Thailand, serves as a development centre to the whole country. The population in Bangkok city, as estimated in the year 2002, was 5.8 million [ADB-CR9, 2005]. The Thai economy had been seriously affected by the financial crisis in Asia during 1997-2000. Even though the situation has not yet fully recovered, the economy there is reported to be growing at a rate of 5.4% in 2002 [ADB-CR9, 2005]. Accordingly, vehicle ownership in Thailand continues to grow after 2000.

Kuala Lumpur, the capital of Malaysia, has been subjected to extensive growth and modernization due to economic development started in 1987 and as a result, new industrial zones have emerged in and around the city [SMURT, 1999]. As estimated in 2000, the population there was about 4.1 million and the average annual growth rate of the population is 3.7%. Malaysia's economy is growing rapidly with an annual GDP growth rate of 5.0% [ADB-CR5, 2005]. According to ADB-CR5 [2005], the number of registered vehicles increases annually by about 6.7%.

Surabaya is the second largest city in Indonesia and is the provincial capital of East Java Province. It is a vital centre for trade and the manufacturing industry in Indonesia and has a population of more than 4 million. As stated by ADB-CR3 [2005], there has been a positive growth in Indonesia's economy in recent years. Vehicle ownership has grown in Indonesia over the years with an increasing rate, especially from 2000 after the recession period in the late 1990s.

3.2 Road Casualty Trends in Thailand, Malaysia, and Indonesia

Positive growth rates in GDP and vehicle ownership in case study areas have a direct influence on road accidents. Using the data from ADB-CR3 [2005], ADB-CR5 [2005], and ADB-CR9 [2005], the casualty trends are constructed for the case study cities (see figures 5(a), 5(b), and 5(c)).

According to figure 5(a), accidents and casualties continued to increase from 1999 in Thailand with a significantly higher rate after the recession period (1997-2000). Also there was a sudden increase of fatalities from 2001. The increase of accidents after the recession period has a direct relationship with increased motor vehicle registration in Thailand from 2000 [ADB-CR9, 2005]. Likewise, there was a steady increase of accidents in Malaysia over the period 1998-2003 (figure 5(b)). The fatality trend in figure 5(b) shows that the total number of people killed in road crashes in Malaysia increased over the period 1997-2000 and decreased after 2000. Other casualties have remained stable after 1997; ADB-CR5 [2005] explained this as a result of the injury control strategy and the safety helmet campaign introduced there.

In contrast, accidents, fatalities and other casualties in Indonesia have significantly reduced since 1997 (figure 5(c)). According to ADB-CR3 [2005], there has been no safety improvement effort since 1997 and the reason for this reduction may be due to the under reporting of accidents. GRSP [2005] also mentioned the problem of the under reporting accidents in less motorised countries.

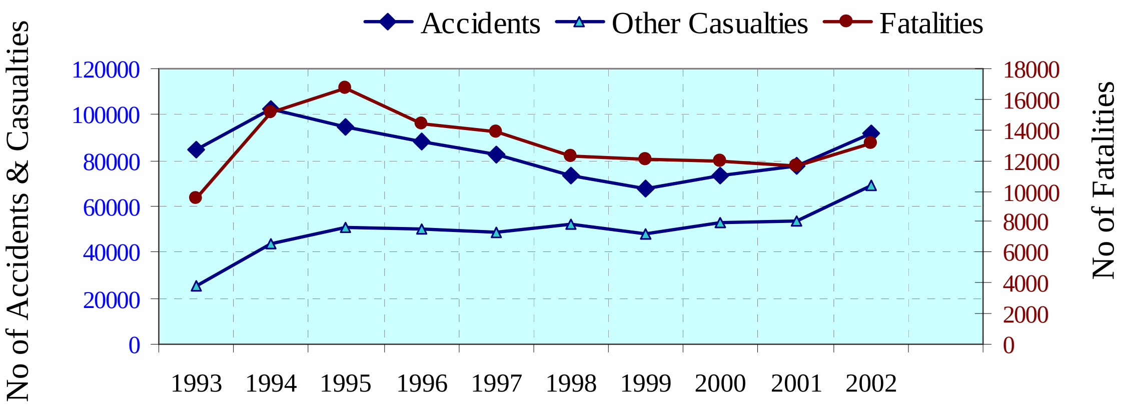


Fig. 5(a) Road Casualty Trends in Thailand (1993-2002)

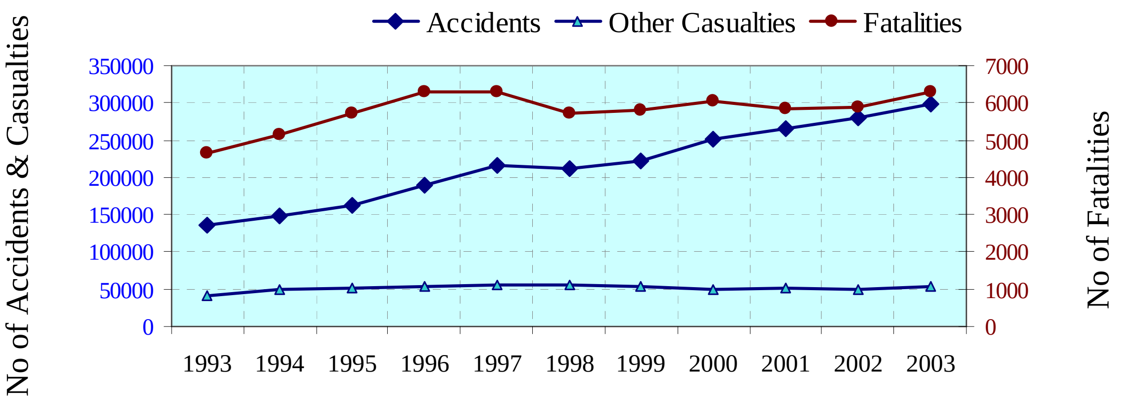


Fig. 5(b) Road Casualty Trends in Malaysia (1993-2003)

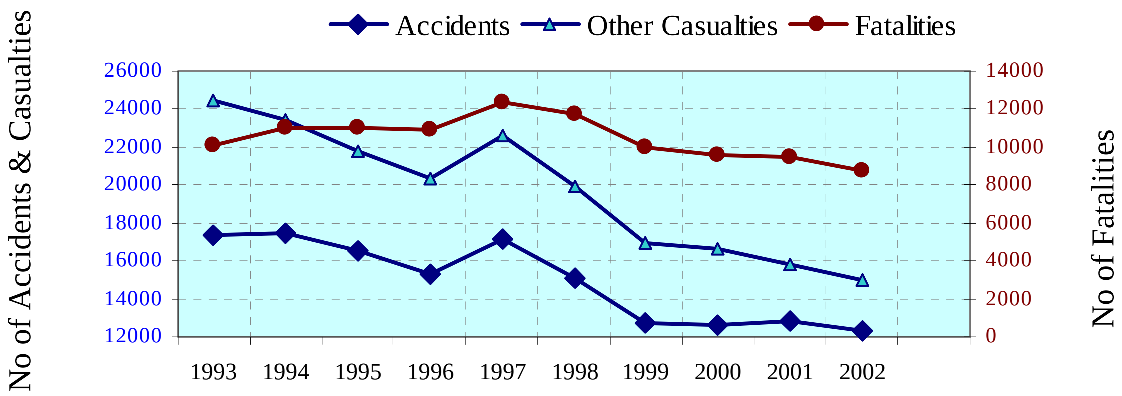


Fig. 5(c) Road Casualty Trends in Indonesia (1993-2002)

3.3 Types of Vehicles Involved in Road Accidents in Thailand, Malaysia and Indonesia

Figures 6(a), 6(b), and 6(c) represent the percentages of each vehicle type involved in road accidents in Thailand (2002), in fatalities in Malaysia (2003), and in road accidents in Indonesia (2002). The data for figure 6 is obtained from the reports published by the Asian Development Bank [ADB-CR3, 2005; ADB-CR5, 2005; and ADB-CR9, 2005]. Figure 7 clearly shows that motorcycles are the most susceptible mode for road accidents (Thailand-38%, Malaysia-57%, Indonesia-73%). Furthermore car accidents also represent high percentages among the countries considered (Thailand-30%, Malaysia-20%, Indonesia-15%).

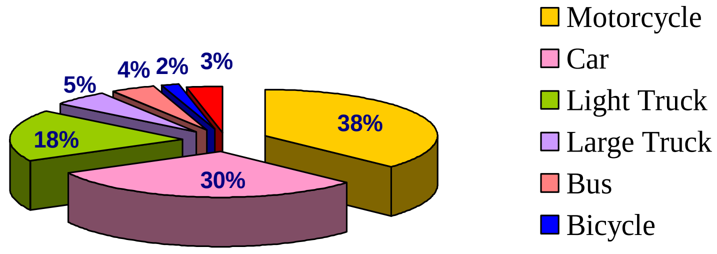


Fig. 6(a) Road Accidents in Thailand (2002)

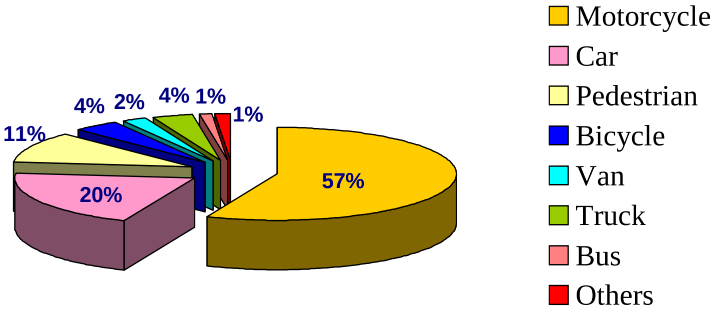


Fig. 6(b) Fatal Road Accidents in Malaysia (2003)

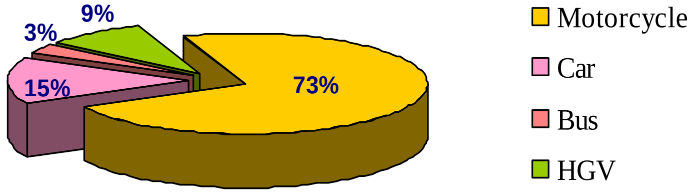


Fig. 6(c) Road Accidents in Indonesia (2002)

3.4 The Distribution of Fatalities/Accidents by Age in Thailand, Malaysia and Indonesia

Figures 7(a), 7(b), and 7(c) represent the distribution of fatalities/accidents by age in Thailand, Malaysia, and Indonesia. The data used for the figures are from ADB reports [ADB-CR3, 2005; ADB-CR5, 2005; and ADB-CR9, 2005]. Accordingly, young people, those between 15-30 years of age, are overrepresented in fatalities/accidents and this is followed by working age adults aged 30-60.

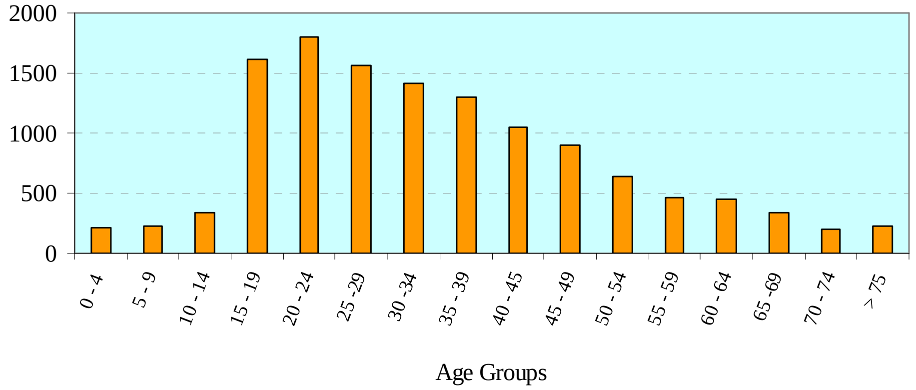


Fig. 7(a) Number of Fatalities Classified by Age Groups in Thailand (1998-2001 average)

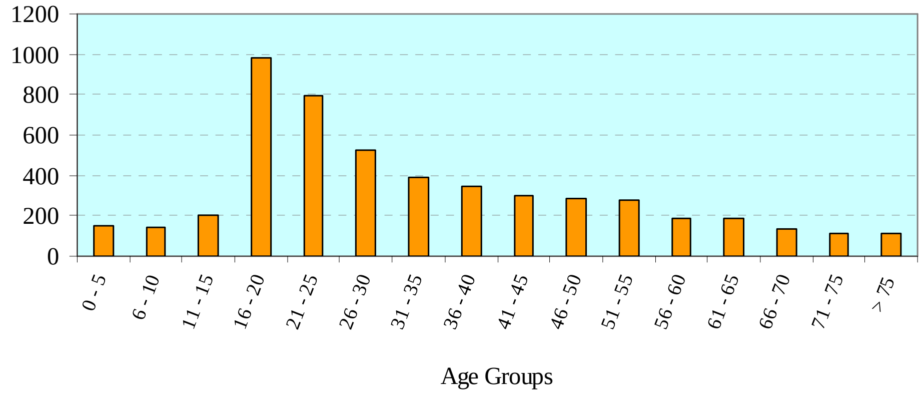


Fig. 7(b) Number of Fatalities Classified by Age Groups in Malaysia (2001)

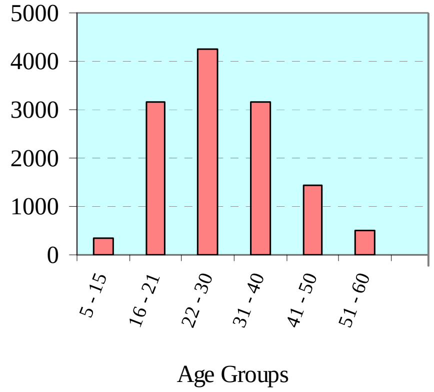


Fig. 7(c) Number of Accidents Classified by Age Groups in Indonesia (2001)

4. METHODOLOGY

The methodology undertaken in this project is aimed at investigating the applicability of the WTP method for valuing road casualties in Asian cities. Modelling WTP using *Discrete Choice Techniques* (DCA) is conceptually appealing as it a new technique for both developed and developing countries. But it has practical problems in being applied to developing countries due to unavailability of data, data biases and inaccuracies.

This project develops MNL models to accomplish inter-regional valuation of road safety considering three Southeast Asian cities.

4.1 Model Formulation- MNL Model

The DCA allows the analyst to describe the utility of an alternative (*U*) using observed variables (*V*) and unobserved factors in the form of an error term (ε). Using the notations proposed by by Ben-Akiva and Lerman (1989), the utility can be expressed as follows:

$$U_{in} = V_{in} + \varepsilon_{in} = \beta' x_{in} + \varepsilon_i \qquad (1)$$

where
U_{in}: the utility of alternative *i* for individual *n.*
V_{in}: the systematic (deterministic) component of utility of *i* for individual *n.*
ε_{in} : the random (disturbance or error) component of utility i for individual *n.*

The individual is always assumed to choose an alternative with the highest utility. However, the utilities are not known to the analyst with certainty. The common practice of treating this uncertainty is by considering them as random variables.

$$P_{in} = P(U_{in} \geq U_{jn},\ \ \forall j \in C_n,\ \ j \neq i) = P(V_{in} + \varepsilon_{in} \geq V_{jn} + \varepsilon_{jn},\ \ \forall j \in C_n,\ \ j \neq i) \qquad (2)$$

where

P_{in}*:* the probability that the individual *n* chooses alternative *i.*
C_n*:* the choice set of the individual *n.*

Under the assumption that ε_n (= ε_{jn}-ε_{in}) is logistically distributed, the probability that individual *n* chooses the alternative *i* (P_{in}) is proposed by Ben-Akiva and Lerman (1989) as:

$$P_n(i) = \frac{e^{V_{in}}}{\sum_{j \in C_n} e^{V_{jn}}} = \frac{e^{\mu(\beta' \mathbf{x}_{in})}}{\sum_{j \in C_n} e^{\mu(\beta' \mathbf{x}_{jn})}} \qquad (3)$$

For a sample of N observations, the following log likelihood function as proposed by Ben-Akiva and Lerman (1985) is considered for the model estimation:

$$L = \sum_{n=1}^{N} \sum_{i \in C_n} \left(\beta' \mathbf{x}_{in} - ln \sum_{j \in C_n} exp^{\beta' \mathbf{x}_{jn}} \right) \tag{4}$$

4.2 Project Framework

The project is conducted using 5 stages as shown in figure 8.

Stage I will focus on an in-depth review of safety valuation, valuation techniques, and social attitudes to road safety as well as risk reduction. Development of data sources is achieved in Stage II. The tasks including data modelling and analysis are accomplished in Stage III. Safety valuation is conduced in Stage VI. Stage V will summarise the research findings and discuss the future directions of the research.

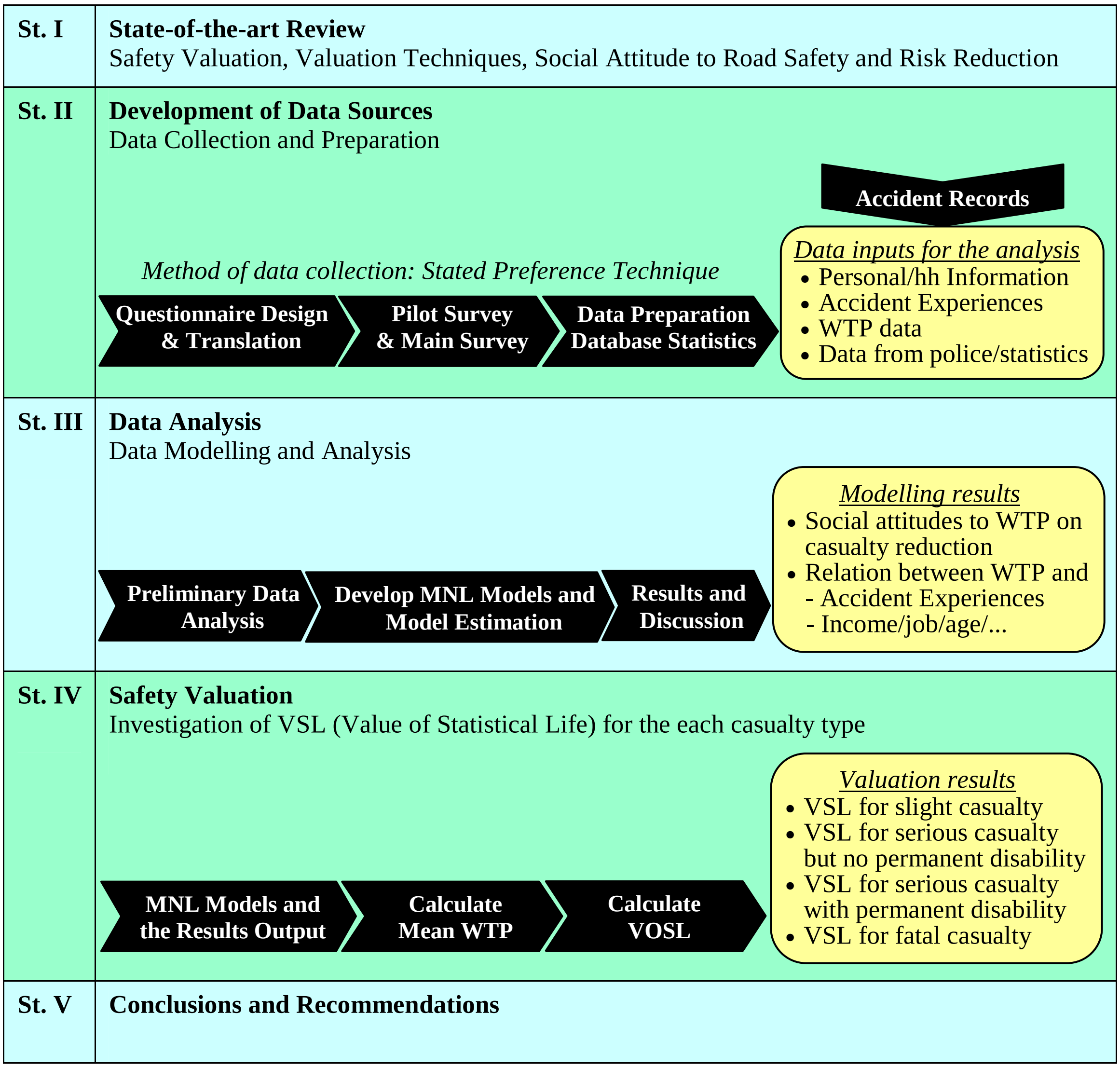


Fig. 8 Project Framework

5. STATE-OF-THE-ART REVIEW

5.1 Road Safety Valuation Techniques

There are several methods available for the valuation of road safety including the net output method, the gross output method (also called the human capital method), and the WTP method. A direct cost element is common in all methods. In the net output method, the total value of the casualty consists of the direct cost and net output loss. The net output loss of the victim is obtained by the present value of the victim's loss of future output after deducting a share for the victim's future consumption. The TRL [1995] explained a person's net output as "a measure of the rest of society's economic interest in his continued survival". In the gross output or human capital method, the direct cost, gross output loss, and human cost should be added together to find the value for the casualty. The gross output loss is generally defined as the present value of the victim's loss of future output. The human cost covers pain, grief, and suffering due to road accidents. This is usually considered to be a percentage of the gross output loss.

Among the available methods, the gross output method and the WTP methods are widely considered in road safety valuation (Jones-Lee, 1982). The gross output method is a very popular method in Asian countries thus far. The *VSL* cannot be fully represented by the value estimated by the WTP method. Since accident victims are not responsible for the losses to society, it is reasonable to consider that they are not to be included in peoples' WTP to reduce casualty risk [Evens, 2006]. As proposed by Evens [2006], the VSL consists of WTP, lost of net output and medical and ambulance costs (direct costs) as:

$$VSL = V(WTP) + V(Net\ Output) + V(Direct\ Cost) \quad (5)$$

Also, it is clear that, $V(Net\ Output) = V(Gross\ Output) - V(Consumption)$ (6)

The cost elements that should be included in the above methods are shown in figure 9.

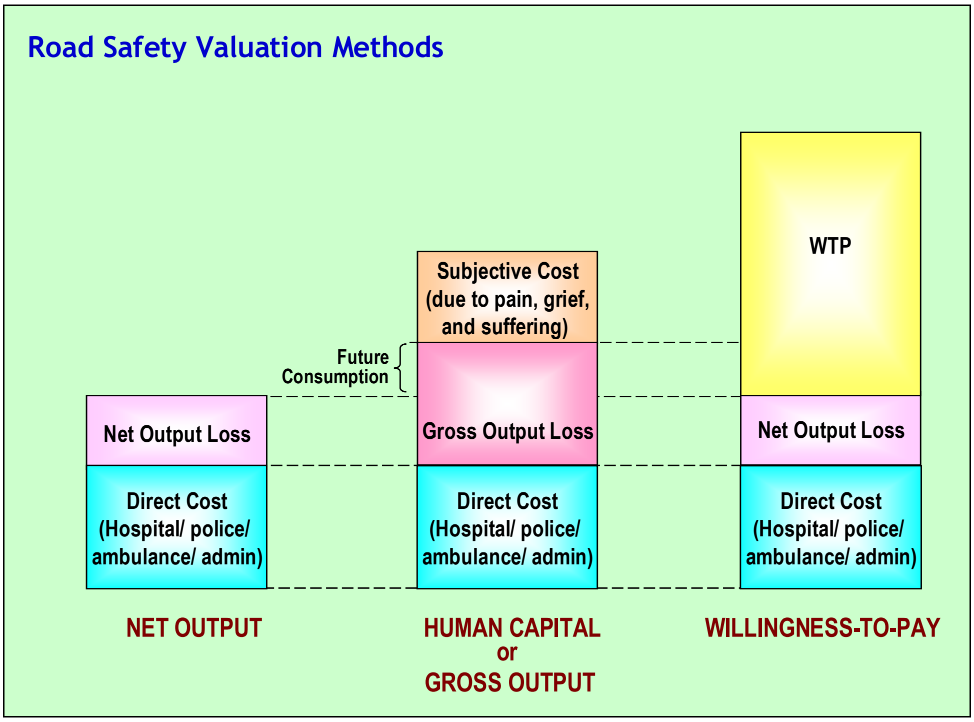


Fig. 9 Cost Elements Considered in Valuation Methods

5.2 Contingent Valuation and Risk Communication

The WTP method includes the following major elements:

- a description of the good being valued, here, casualty type and risk description,
- a description of the payment vehicle or market in which the good is exchanged, and
- the method of obtaining respondents' willingness-to-pay.

Whether the good is a *private good* or a *public good* is important for identifying the value measure. For a *private good,* risk is reduced on a personal level. On the other hand, if a safety measure benefits everyone in the society, the good being valued is to be considered to be a public good. Most safety applications have dealt with only private-good aspects (i.e. the value of reduction in personal risk) because of the free-rider problem associated with public goods. However, Strand (2002) pointed out that spending for traffic safety has an inherently public good aspect, since safety improvements affect the statistical risk of each person. According to Strand (2002), "Willingness-to-pay to reduce mortality risks may clearly involve the individual's valuation of others' death risk reduction, both family members and third persons".

A problem that is somewhat unique to the safety context is *risk communication*. The good being valued here – a reduction in the risk of being injured in a road accident – must be clearly described and include information about initial risk and the risk change (Schwab and Soguel, 1995).

In general, the description of the risk scenario has a major influence on the respondents' degree of comprehension, and consequently, their answers. A defensible survey study for the purpose of evaluating risk changes must ensure that respondents understand the commodity they are being asked to value.

According to Ball (2000), people do not necessarily hold well-defined preferences toward changes in risk. Thus, survey responses might therefore not be an accurate measure of true preferences. A problem for risk valuation is that people are poor judges of the nature and magnitude of physical risks they face, especially considering for low risks. People do not quantify the risks they face everyday, and they appear to exhibit some common characteristics in their perception of risk, including overestimating small risks, valuing risk changes asymmetrically (from some reference point), and having a concern for specific characteristics of the risk independent of the magnitude of risk (McDaniels et al., 1992).

There are a variety of methods for eliciting the WTP. Three methods of designing questions are: *open-ended, dichotomous choice* and *payment card format* (Reaves et al., 1999). Researchers compare these methods to determine their advantages and disadvantages.

The Open-ended Format:

In this method, the respondents are asked directly to state their WTP (what is the maximum amount they would be willing to pay for a described good). This is an iterative method. A certain amount is first offered to the respondents in this method. If they agree to pay, the initial amount is gradually increased until the respondents refuse to buy the good. The last bid accepted represents their WTP. This method requires a personal interview and is subject to interviewer bias.

Jones-Lee et al. (1985) has conducted extensive studies and surveys. One national sample survey was conducted for the U.K. Department of Transport in 1982 to measure WTP to avoid a statistical fatality. Persson et al. (1995) reported the findings of a WTP study to value non-fatal injuries carried out in 1993 by the Swedish Institute for Health Economics (IHE) and the Department of Traffic Planning and Engineering, Lund University.

The Dichotomous Choice Format:

In this method, a pre-determined price is chosen and respondents are asked if they are willing to buy the good at that given price. They give a simple "yes" or "no" answer. If the price is lower than their WTP, they will buy; if it is higher, they will refuse. With this method, many observations may be needed to estimate the WTP distribution. This method is recommended by the National Oceanic and Atmospheric Administration (NOAA) panel because of its incentive properties (Arrow et al., 1993).

The Payment Card Format:

In the *payment card format*, respondents are presented with a list of specific amounts, say in US$ or GBP. Respondents choose the highest value from the list that they are WTP.

Reaves et al. (1999) observed that the *payment card format* exhibits desirable properties relative to the other two formats; their results suggest that the *payment card format* may ease the valuation task faced by the survey respondents and lead to efficiencies in data collection. Jones-Lee et al. (1993) also applied contingent valuation to value non-fatal road injuries using the payment card method.

Schwab and Soguel (1996) conducted a study in Switzerland to determine the human costs of motor vehicle crashes using the WTP method. In that study the human costs were defined to be: loss of life expectancy of the deceased victims; the physical and mental suffering of victims (pain, grief, and suffering, impaired quality of life, permanent cosmetic damage); and the mental suffering of the victims' relatives (pain, grief, and suffering and impaired quality of life). Separate estimates for the victims and their relatives were obtained using two separate questionnaires. Respondents were asked to answer the first questionnaire as potential victims of a motor vehicle crash, and the second as relatives of potential victims. In both cases, they were asked to state their willingness to avoid the human costs defined above. In addition to making the risk easier to understand, it was hoped that the risk description would encourage the respondent to feel more concerned about road accident problems.

In Denmark, the Danish Road Directorate carried out a study to determine people's valuation of increased traffic safety using the contingent valuation method. Both fatality and injuries were included in the study. Kidholm (1995) presented the results of the study, but many details are lacking.

5.3 Safety Valuation Studies in Thailand, Malaysia and Indonesia

ADB-AC9 [2005] mentioned that only a little effort has been put on road casualty costing in Thailand due to lack of systematic databases of accidents. Luathep and Tanaboriboon [2005] analysed road crash costs in Thailand using the human capital method. As they reported, the values of fatal, serious, and slight casualties in Thailand are B 3,050,112, B 193,648, and B 25,400 respectively. They particularly mentioned that the other valuation methods are not possible in Thailand due to data limitations. Table 1 demonstrates the costing projects that have taken place in Thailand to date. As proposed by ADB-AC9 [2005], the estimated values for fatal, serious, and slight casualties are B 2,852,924, B 142,273, and B 21,162 respectively.

Until recently, there was no proper valuation system used in Malaysia. One of the earlier studies in 1985 by the United Nations Economic and Social Commission for Asia and Pacific (ESCAP) attempted to value road casualties using the gross output method; the value of the fatal casualty was estimated as MR 145,000 (= MR 238,585 in 2004 prices) [Fauzi et al, 2004]. A recent study by Fauzi et al. [2004] used the WTP method to cost road casualties in Malaysia; accordingly *the Value of Statistical Life* (*VSL*) was found to vary over the range of MR 900,000 – 1,220,000. They suggested an average figure for VSL as MR 1,100,000. The ADB study in 2004 also used the WTP method to value road casualties in Malaysia [ADB-AC5, 2005]. The estimates proposed by ADB-AC5 [2005] were RM 1,200,000, RM 120,000 and RM 12,000 for fatal, serious, and slight casualties. The costing projects that have taken place in Malaysia are tabulated in table 2.

Several projects have been conducted in Indonesia over the last decade on this subject. As per the Highway Capacity Manual Project (HCM) in 1995, the casualty costs were estimated using the human capital method; the cost estimates for fatal, serious, and slight categories were reported as Rp 30,100,000, Rp 2,600,000, and Rp 500,000 (in 1991 prices) [Downing, 1997]. A recent study by Sari and Sutomo [2004] estimated casualty costs in Indonesia. According to their investigation, the values for fatal, serious, and slight casualties were reported as Rp 327,338,385, Rp 21,365,939, and Rp 6,082,118. The casualty costing estimates suggested by ADB-AC3 [2005] are comparable to the findings from Sari and Sutomo [2004]. Due to the under reporting of road casualties as well as inefficient record keeping systems, the available casualty databases in Asian countries may not be considered as reliable inputs for the valuation studies [ADB-AC2, 2005; ADB-AC3, 2005]. Table 3 summarises the costing projects that have taken place in Indonesia to date.

The TRL [1995] has recommended the gross output method for developing countries due to the complications of the WTP approach. As explained by Downing [1997], the gross output method can be appropriately used to achieve the objective of maximising the wealth of the country. However it is not suitable for cost-benefit analysis. The WTP method suitably meets the requirements of welfare objectives as well as cost-benefit analysis. At present, the WTP method is limited to developed countries. As mentioned by Downing [1997], it is difficult to apply for developing countries.

Until 2004, the valuation studies in Asia have been confined to the gross output method; Fauzi et al. [2004] is the first attempt to apply the WTP method in Malaysia. This study therefore attempts to extend the WTP methodological approach over three large metropolitan areas in Asia. The social WTP for road casualties will be analysed using *State-of-the-art Discrete Choice Modelling Technique*.

Table 1 Valuation Studies in Thailand

Studies in Thailand	Casualty Type	Valuation Method Used
		HUMAN CAPITAL (in B)
AIT Study Ref: Luathep and Tanaboriboon [2005]	Fatal	3,050,112 *
	Serious	193,648 *
	Slight	25,400 *
ADB Study Ref: ADB-AC9 [2005]	Fatal	2,852,924 **
	Serious	142,273 **
	Slight	21,162 **

* AIT-2002 Study: Human costs < B 210,000 for fatal, B 91,500 for serious, B 7,300 for slight casualties>
** ADB-2005 Study: Human costs < B 536,038 for fatal, B 53,656 for serious, B 379 for slight casualties>

Table 2 Valuation Studies in Malaysia

Studies in Malaysia	Casualty Type	Valuation Method Used	
		GROSS OUTPUT (in RM)	WTP (in RM)
ESCAP Project, 1985	Fatal	238,585 (at 2004 prices)	–
Ref: Fauzi et al. [2004]	Fatal/ Serious/ Slight	–	900,000 ~1,220,000
ADB Study Ref: ADB-AC9 [2005]	Fatal	–	1,200,000
	Serious	–	120,000
	Slight	–	12,000

Table 3 Valuation Studies in Indonesia

Studies in Indonesia	Casualty Type	Valuation Method Used	
		GROSS OUTPUT (in Rp) *No human costs included*	HUMAN CAPITAL (in Rp)
Highway Capacity Manual Project (HCM), 1995. Ref: Downing [1997]	Fatal	21,800,000	30,100,000 *
	Serious	1,300,000	2,600,000 *
	Slight	460,000	500,000 *
Refs: Sari and Sutomo [2004] ADB-AC3 [2005]	Fatal	255,733,113	327,338,385 **
	Serious	14,243,959	21,365,939 **
	Slight	5,631,591	6,082,118 **

* HCM Project: Human costs < +38% for fatal, +100% for serious, +8% for slight casualties>
** Sari and Sutomo [1997] and ADB-AC3 [2005]: Human costs < +28% for fatal, +50% for serious, +8% for slight casualties>

6. DEVELOPMENT OF DATA SOURCES

This stage consists of the activities related to questionnaire design, data collection (pilot and main survey) and data preparation for the analysis.

6.1 Questionnaire Design

Since WTP is a new issue in the developing world, the questionnaire was developed using *Stated Preference (SP) Contingent Valuation Methods*. The questionnaire was particularly designed to collect information from the general public regarding their WTP for car and motorcycle casualty reduction. It consists of three main sections:

<u>Section I:</u> Individual and household information

Individual information includes the respondent's gender, age, education, occupation, personal income per month, monthly savings, transport mode for daily travel, and the number of cars and motorcycles owned by the respondents.

If the respondent is married and has a family, s/he was further requested to provide information such as spouse's occupation, spouse's monthly income, household monthly savings, and the number of children.

<u>Section II:</u> Past experiences on road casualties

In order to capture the relationship between respondents' casualty experience and their WTP for casualty reduction in the analysis, the questionnaire is designed to gather their past casualty experiences. All kinds of experiences that they have, for instance personal experience, household experience (spouse, children), and experiences related to their close community (parents, siblings, relatives, friends), were requested from the respondents. Figure 10 below explains the questions included in the questionnaire to collect casualty experiences.

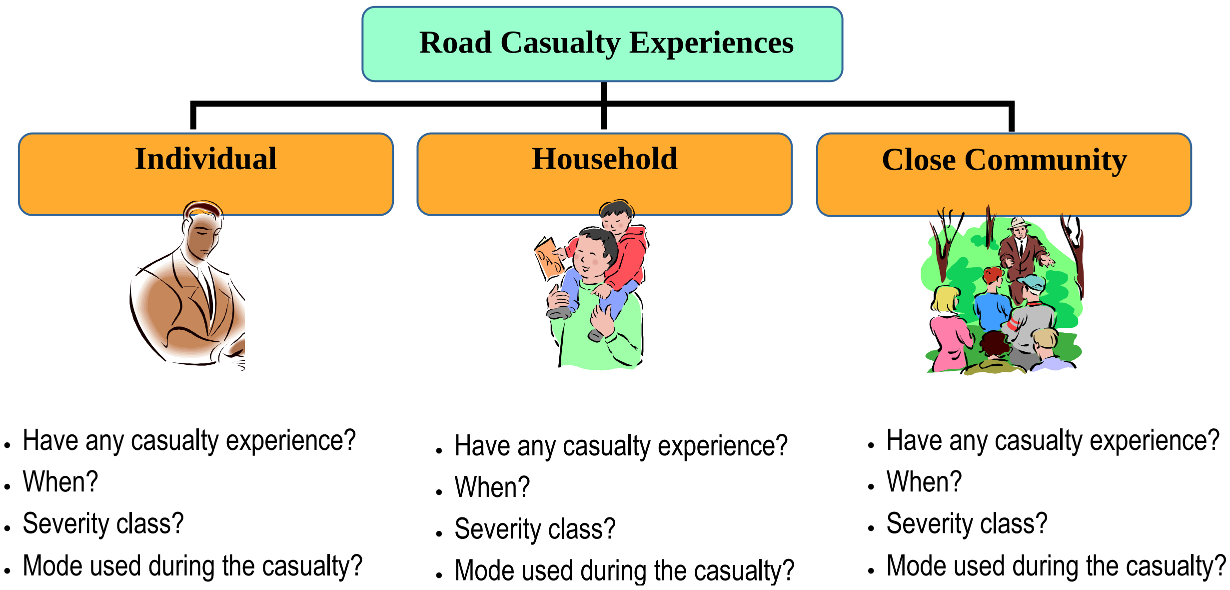
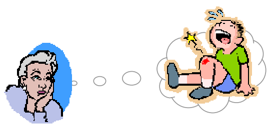


Fig. 10 Questionnaire - Collecting Casualty Experiences

***Section III*: WTP for reducing car/motorcycle casualties**

Four SP Cards were designed to gather information from respondents' WTP for the reduction of motorcycle casualties (MC-SC1, MC-SC2, MC-SC3, and MC-SC4) (figures 11(a), 11(b), 11(c), and 11(d) for the case of Bangkok). Each card contains motorcycle casualty statistics in Thailand to make the respondent aware of the severity of the problem. Then they were asked to decide the amount that they were willing to pay for a 25% casualty reduction considering each severity class at a time. They were reminded to decide the payment with explicit consideration of pain, grief, and suffering of the casualties as well as their income and savings; this is important to have valid WTP values. This may avoid the situation in which the respondents' WTP value is more than their monthly savings.

SP Card 1- Willingness to Pay for the Reduction of Slight Casualties



Q14

Annually, 658 in 100000 motorcycles contribute for slight injuries in Thailand.
The total cost per slightly injury is estimated as Baht 2,223.

Road safety improvements (pedestrian crossings, traffic signals) would reduce <u>slight casualties</u> benefiting you, your family and the neighbouring community.

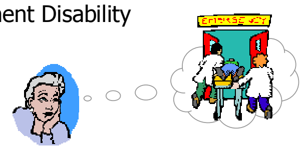
To reduce <u>motorcycle slight casualties from 25%,</u>
how much would you be willing to pay annually for road safety improvement in your area?

Please remember that your answer should reflect your value of avoiding pain, suffering, and bereavement as well as lost time.
Also consider your income and savings before making your choice.

☐0B ☐5B ☐10B ☐25B ☐50B ☐100B ☐250B ☐500B ☐1000B

Fig. 11(a) SP Card 1: Willingness-to-Pay for Reducing Motorcycle Slight Casualties (MC/SC1)

SP Card 2- Willingness-to-Pay for the Reduction of Serious Casualties with No Permanent Disability



Q15

Annually, 141 in 100000 motorcycles contribute for serious injuries in Thailand.
The total cost per serious injury is estimated as Baht 96,909.

Road safety improvements (pedestrian crossings, traffic signals) would reduce <u>serious casualties</u> benefiting you, your family and the neighbouring community.

To reduce <u>motorcycle serious casualties from 25%,</u>
how much would you be willing to pay annually for road safety improvement in your area?

Please remember that your answer should reflect your value of avoiding pain, suffering, and bereavement as well as lost time.
Also consider your income and savings before making your choice.

☐0B ☐5B ☐10B ☐25B ☐50B ☐100B ☐250B ☐500B ☐1000B

Fig. 11(b) SP Card 2: Willingness-to-Pay for Reducing Motorcycle Serious Casualties with no Permanent Disability (MC/SC2)

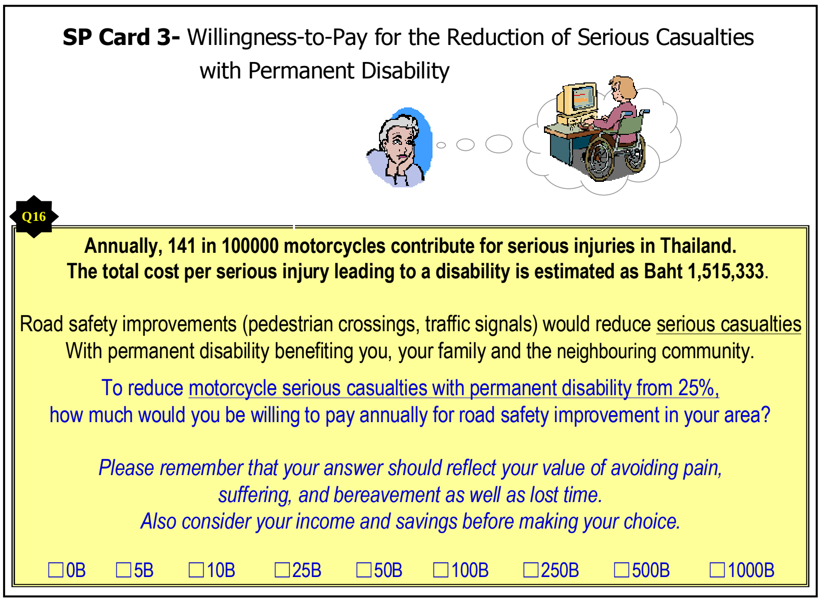


Fig. 11(c) SP Card 3: Willingness-to-Pay for Reducing Motorcycle Serious Casualties with Permanent Disability (MC/SC3)

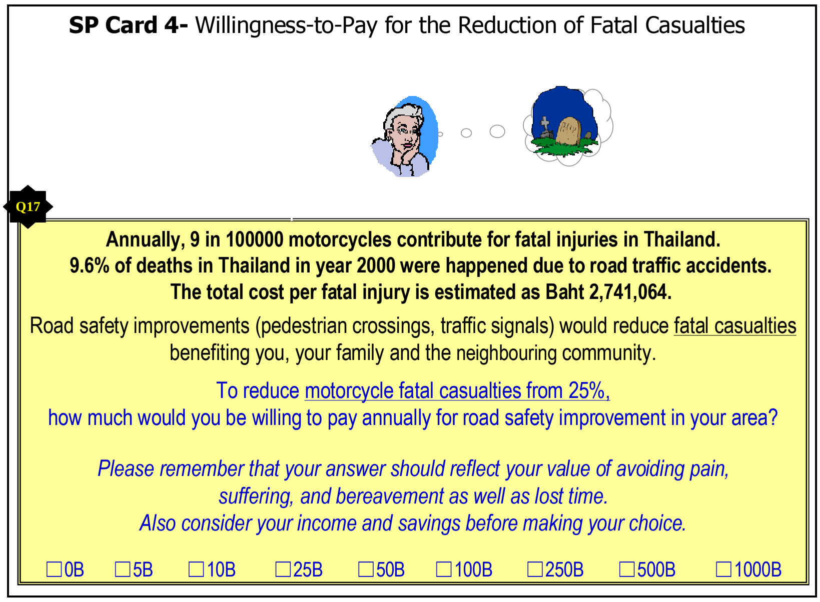


Fig. 11(d) SP Card 4: Willingness-to-Pay for Reducing Motorcycle Fatal Casualties (MC/SC4)

Four SP cards were designed to collect WTP data for car casualties in Thailand (C-SC1, C-SC2, C-SC3, and C-SC4). Altogether 24 cards were developed for Thailand, Malaysia, and Indonesia.

Once the questionnaires were designed, they were translated to Thai, Malay, and Basha Indonesia.

6.2 Pilot Survey and Main Survey

The questionnaires were piloted using Thai, Malaysian and Indonesian postgraduate students at Newcastle University during June 2006. By doing so, problems that may have occurred in the main survey were properly identified and amended before conducting the main survey in the three case study cities. Table 4 and figure 12 below explain the details about the main surveys that took place in Bangkok, Kuala Lumpur, and Surabaya.

Table 4 Information related to the Main Surveys Happened in Three Case Study Areas

Case Study City	Survey Period	Car Questionnaires	Motorcycle Questionnaires
Bangkok	Aug′06 – Jan′06	300	298
Kuala Lumpur	Sept′06 – Feb′07	400	400
Surabaya	July′06 – Oct′06	414	431

Fig. 12 Information Related to the Main Surveys in the Case Study Areas

6.3 Data Preparation

Once the data collection was completed in the three case study cities, they were systematically coded as appropriate for the modelling purposes and tabulated in excel worksheets. Six databases were finally created for the case studies (3-car related databases, 3-motorcycle related databases). Once the databases were completed they were transformed to Gauss Data by using Gauss Data Tool. The models were developed using Gauss Matrix Multiplication Software.

6.4 Database Statistics

The Gauss Databases were then used to explore the database composition over the respondents' income, the level of education, car and motorcycle ownership, and the casualty experiences considering their own (individual) experience, other household members (spouse or children) experience, and community-based (parents, relatives or friends) experience. See Appendix A for more information. The abbreviations BKK/C, BKK/MC, KL/C, KL/MC, SU/C, and SU/MC represent Bangkok-Car Database, Bangkok-Motorcycle Database, Kuala Lumpur-Car Database, Kuala Lumpur-Motorcycle Database, Surabaya-Car Database, Surabaya-Motorcycle Database respectively.

6.4.1 Bangkok-Car Database (BKK/C)

The database is normally distributed over the respondents' income and education (Appendix A1 and A2). There are 73% car owners and 27% no car owners in the database (Appendix A3). 47% of the respondents who completed the BKK/C questionnaire have experience of casualties (Appendix A4). Only 20% of them reported that their household members have past casualty experience. 43% of respondents stated that they were aware of casualty experiences involving people in their close community including their parents, siblings, relatives, or friends (Appendix A4).

6.4.2 Bangkok-Motorcycle Database (BKK/MC)

Similar to the BKK/C database, the BKK/MC database is also distributed normally over the income and education (Appendix A5, A6). 64% of the respondents are motorcycle owners (Appendix A7). 39% have individual casualty experience and 17% have household related casualty experience. 43% of them have community related casualty experiences (Appendix A8).

6.4.3 Kuala Lumpur-Car Database (KL/C)

The KL/C database mainly composed of very low, low, and medium income respondents (Appendix A9). The respondents' education is normally distributed over four groups including elementary, secondary, college, and university (Appendix A10). 76% of respondents are car owners (Appendix A11). 65% have individual casualty experience and 30% have household related casualty experience. 62% of them have community related casualty experiences (Appendix A12).

6.4.4 Kuala Lumpur-Motorcycle Database (KL/MC)

Similar to the KL/C database, the KL/MC database consists of very low, low, and medium income respondents (Appendix A13). 68% of the respondents are motorcycle owners (Appendix A15). 66% have individual casualty experience and 33% have household related casualty experience. 70% of them have community related casualty experiences (Appendix A16).

6.4.5 Surabaya-Car Database (SU/C)

The database is normally distributed over the respondents' income and education (Appendix A17 and A18). There are 82% car owners (Appendix A19). 66% of the respondents who completed the SU/C questionnaire have experience of casualties (Appendix A19). Only 42% of them reported that their household members have past casualty experience. 71% of respondents stated that they were aware of casualty experiences happening to people in their close community including their parents, siblings, relatives or friends (Appendix A20).

6.4.6 Surabaya-Motorcycle Database (SU/MC)

The SU/C database primarily consists of very low, low, and medium income respondents (Appendix A21). The respondents' education is normally distributed over four groups including elementary, secondary, high school, university, and other (Appendix A22). 77% of respondents are car owners (Appendix A23). 35% have individual casualty experience and 30% have household related casualty experience. 69% of them have community related casualty experiences (Appendix A24).

7. DATA ANALYSIS

7.1 Preliminary Data Analysis

The social attitudes to WTP for road casualty reduction have been examined using the data collected from the three case study areas.

7.1.1 Investigation of Social Attitudes to WTP in Bangkok

Figure 13 represents the social attitudes to WTP for a 25% car casualty risk reduction over four severity classes [C/SC1, C/SC2, C/SC3, and C/SC4]. WTP0, WTP5, WTP10, WTP25, WTP50, WTP100, and WTP250 indicate the respondents' payment choice options of 0 Thai Baht (B), 5B, 10B, 25B, 50B, 100B, and 250B respectively. It is clear that the WTP increases when the severity of the casualty increases. For instance, only 18% of respondents pay 50 Thai Baht or more for slight casualty risk reduction (C/SC1). This share increases up to 33% for C/SC2, up to 49% for C/SC3, and up to 62% for C/SC4.

For the reduction of motorcycle casualties by 25%, the respondents' WTP is represented in figure 13 over MC/SC1, MC/SC2, MC/SC3, and MC/SC4. The variation of the WTP for motorcycle casualty reduction is highly comparable with the case of car casualty reduction as figures 13 and 14 show a similar trend over social WTP.

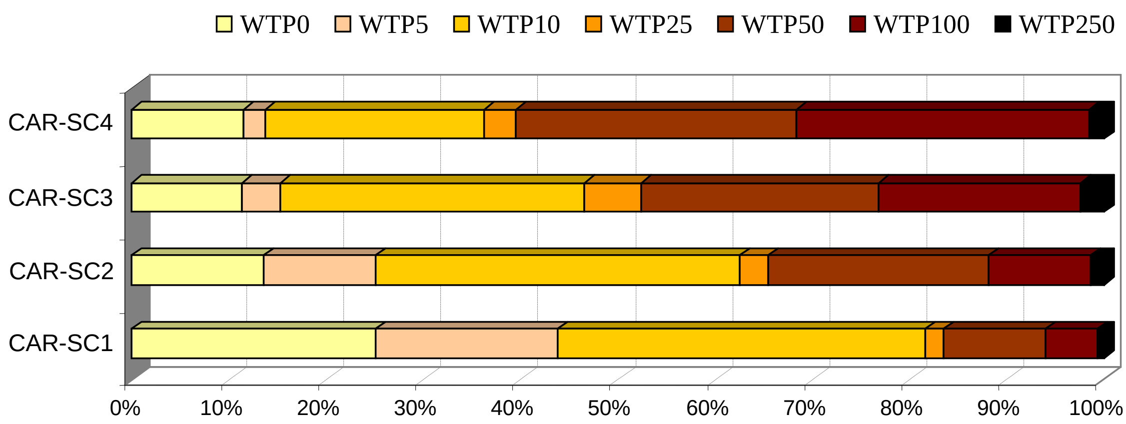


Fig. 13 WTP Selection for a 25% Risk Reduction - BKK/C Database

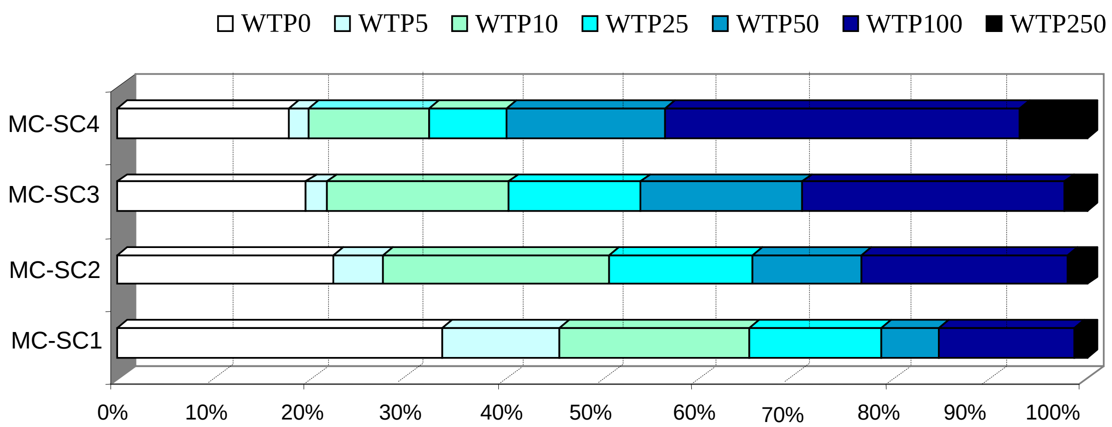


Fig. 14 WTP Selection for a 25% Risk Reduction - BKK/MC Database

7.1.2 Investigation of Social Attitudes to WTP in Kuala Lumpur

Figures 15 and 16 below show the respondents' WTP for the reduction of car and motorcycle casualties by 25% over four severity classes. WTP0, WTP5, WTP10, WTP25, WTP100, WTP250, WTP500, and WTP1000 indicate the respondents' payment choice options of 0 Malaysia Ringgits (RM), RM 5, RM 10, RM 25, RM 100, RM 250, RM 500, and RM 1000 respectively. From both figures, it is very clear that the respondents' WTP increases with the increasing severity of the casualty. Regarding the risk reduction of serious or fatal casualties, the respondents are willing to pay a higher amount than they pay for slight casualties.

Also when the severity class increases, no-WTP [WTP0] decreases. Respondents are less likely to pay large amounts, for example RM 250-1000 [WTP250, WTP500, WTP1000], for slight casualty reduction but they are more likely to pay considerable sums of money for the reduction of serious and fatal casualties. As per figure 15, 32% of the respondents are likely to pay more than or equal to RM 250 for fatal accident risk reduction. The share decreases to 27% for serious with disability risk, 15% for serious without disability risk, and 12% for slight casualty risk. This is equally correct for both car and motorcycle databases collected in Kuala Lumpur.

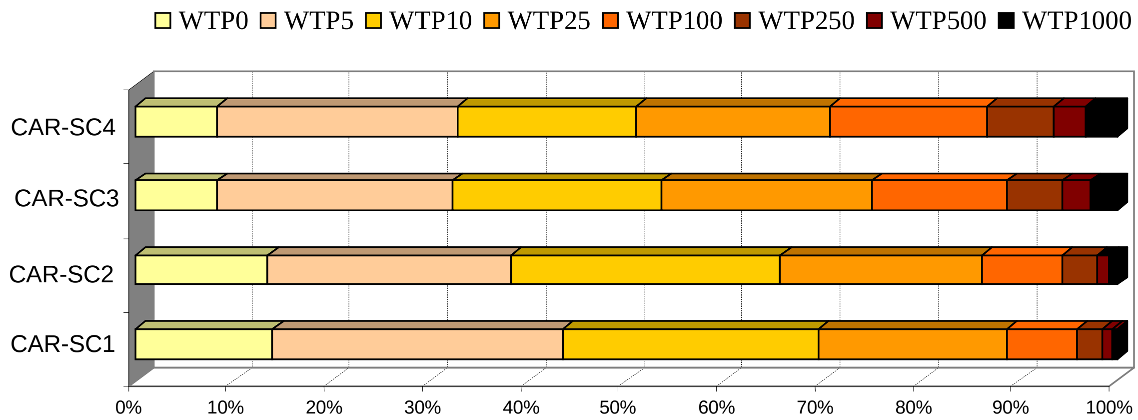


Fig. 15 WTP Selection for a 25% Risk Reduction – KL/C Database

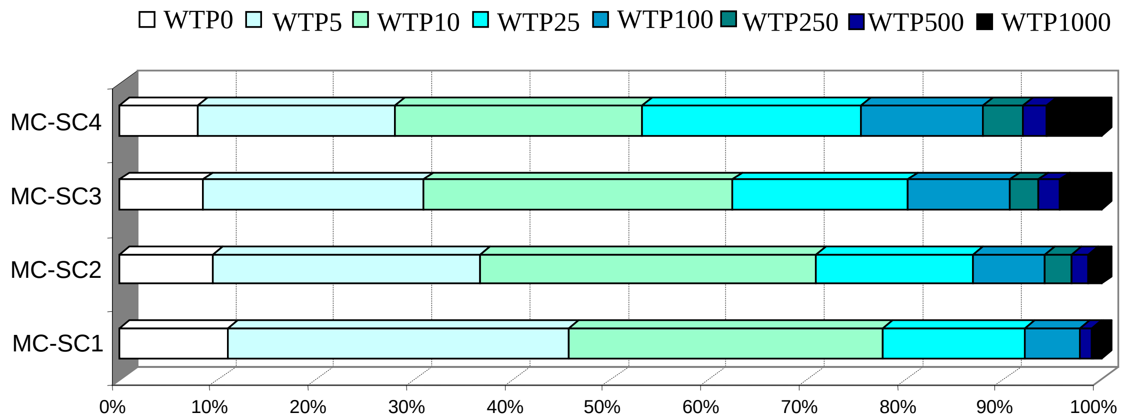


Fig. 16 WTP Selection for a 25% Risk Reduction – KL/MC Database

7.1.3 Investigation of Social Attitudes to WTP in Surabaya

The respondents' WTP for the reduction of car and motorcycle casualties by 25% over four severity classes are represented in figures 17 and 18 below. WTP0, WTP1000, WTP5000, WTP10000, WTP25000, WTP50000, and WTP100000 indicate the respondents' payment choice options of 0 Rupiah (Rp), Rp 5, Rp 10, Rp 25, Rp 100, Rp 250, Rp 500, and Rp 1000 respectively. Both figures show that the respondents' WTP increases with the increasing severity of the casualty and this is very similar to other case study cities. For serious or fatal casualty risk reduction, the respondents' wishes to pay a higher amount than they pay for slight casualties. Also when the severity class increases, no-WTP [WTP0] slightly decreases. Respondents are less likely to pay large amounts, for example 25000-100000 Rp [WTP25000, WTP50000, and WTP100000], for slight casualty reduction but they are more likely to pay considerable sums of money for the reduction of serious and fatal casualties.

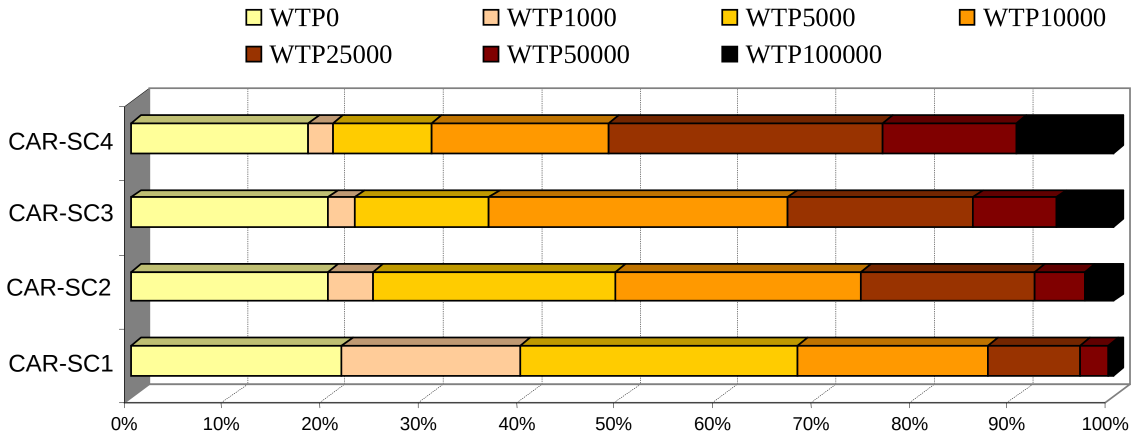


Fig. 17 WTP Selection for a 25% Risk Reduction – SU/C Database

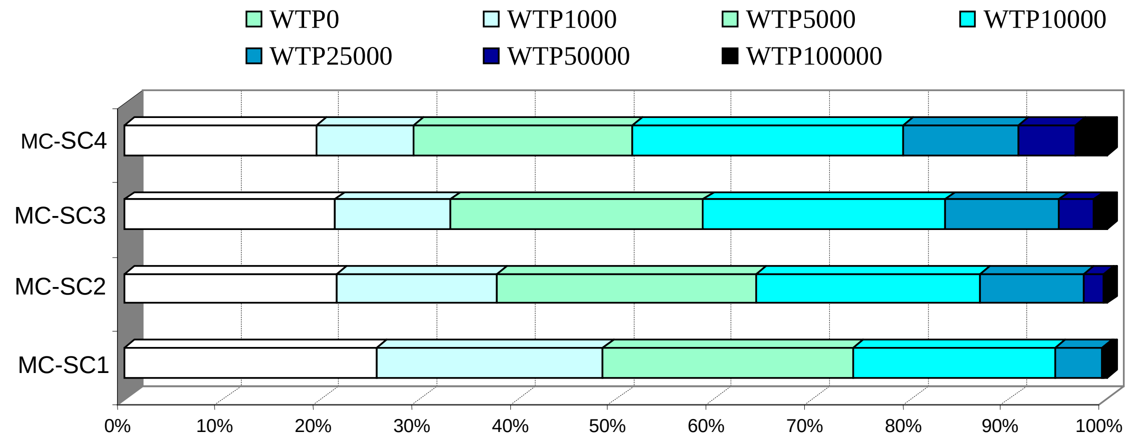


Fig. 18 WTP Selection for a 25% Risk Reduction – SU/MC Database

The WTP may not just be dependent upon the severity of the casualty. It is expected that the respondents' income, past casualty experiences, and their perceptions and feelings about casualty reduction could equally be valid for their attitude towards paying and reduce road casualties. These factors are expected to be investigated in the detailed analysis in this study (see sections 7.2 and 7.3).

7.2 Development of MNL Models and Model Estimation

7.2.1 Model Development

The MNL models have been developed using the databases prepared for Bangkok, Kuala Lumpur, and Malaysia. Table 5 below provides the details of the models developed in this study.

Eight MNL models have been developed for each case study city; four of them are related to social WTP for car related casualty reduction by 25% considering severity classes SC1, SC2, SC3, and SC4, and the other four models are for motorcycle related casualty reduction by 25%.

Table 5 Models Developed using the Data from Bangkok, Kuala Lumpur, and Surabaya

City	Type	Severity Class	Model ID.	Purpose
Bangkok (BKK)	Car	SC1	BKK/C/SC1	WTP for reducing car-related slight casualties (SC1) by 25%
		SC2	BKK/C/SC2	WTP for reducing car-related serious casualties (SC2) by 25%
		SC3	BKK/C/SC3	WTP for reducing car-related serious casualties (SC3) by 25%
		SC4	BKK/C/SC4	WTP for reducing car-related fatal casualties (SC4) by 25%
	Motorcycle	SC1	BKK/MC/SC1	WTP for reducing motorcycle-related slight casualties (SC1) by 25%
		SC2	BKK/MC/SC2	WTP for reducing motorcycle-related serious casualties (SC2) by 25%
		SC3	BKK/MC/SC3	WTP for reducing motorcycle-related serious casualties (SC3) by 25%
		SC4	BKK/MC/SC4	WTP for reducing motorcycle-related fatal casualties (SC4) by 25%
Kuala Lumpur (KL)	Car	SC1	KL/C/SC1	WTP for reducing car-related slight casualties (SC1) by 25%
		SC2	KL/C/SC2	WTP for reducing car-related serious casualties (SC2) by 25%
		SC3	KL/C/SC3	WTP for reducing car-related serious casualties (SC3) by 25%
		SC4	KL/C/SC4	WTP for reducing car-related fatal casualties (SC4) by 25%
	Motorcycle	SC1	KL/MC/SC1	WTP for reducing motorcycle-related slight casualties (SC1) by 25%
		SC2	KL/MC/SC2	WTP for reducing motorcycle-related serious casualties (SC2) by 25%
		SC3	KL/MC/SC3	WTP for reducing motorcycle-related serious casualties (SC3) by 25%
		SC4	KL/MC/SC4	WTP for reducing motorcycle-related fatal casualties (SC4) by 25%
Surabaya (SU)	Car	SC1	SU/C/SC1	WTP for reducing car-related slight casualties (SC1) by 25%
		SC2	SU/C/SC2	WTP for reducing car-related serious casualties (SC2) by 25%
		SC3	SU/C/SC3	WTP for reducing car-related serious casualties (SC3) by 25%
		SC4	SU/C/SC4	WTP for reducing car-related fatal casualties (SC4) by 25%
	Motorcycle	SC1	SU/MC/SC1	WTP for reducing motorcycle-related slight casualties (SC1) by 25%
		SC2	SU/MC/SC2	WTP for reducing motorcycle-related serious casualties (SC2) by 25%
		SC3	SU/MC/SC3	WTP for reducing motorcycle-related serious casualties (SC3) by 25%
		SC4	SU/MC/SC4	WTP for reducing motorcycle-related fatal casualties (SC4) by 25%

The MNL model structures for Bangkok, Kuala Lumpur, and Surabaya are shown in figures 19, 20, and 21 respectively.

The questionnaires developed for Bangkok consist of seven WTP alternatives: WTP0, WTP5, WTP10, WTP25, WTP50, WTP100, and WTP250 (see figure 19) and therefore the MNL models for Bangkok have seven choice options. The respondents have been provided with an opportunity to select the best WTP option. Before deciding the choice, they have been reminded to consider their socio-economic status and their past casualty experiences. Altogether eight models were developed to investigate the social attitudes and their WTP for the reduction of car and motorcycle casualties by 25%.

Models for Bangkok:
Car: BKK/C/SC1, BKK/C/SC2, BKK/C/SC3, and BKK/C/SC4
Motorcycle: BKK/MC/SC1, BKK/MC/SC2, BKK/MC/SC3, and BKK/MC/SC4

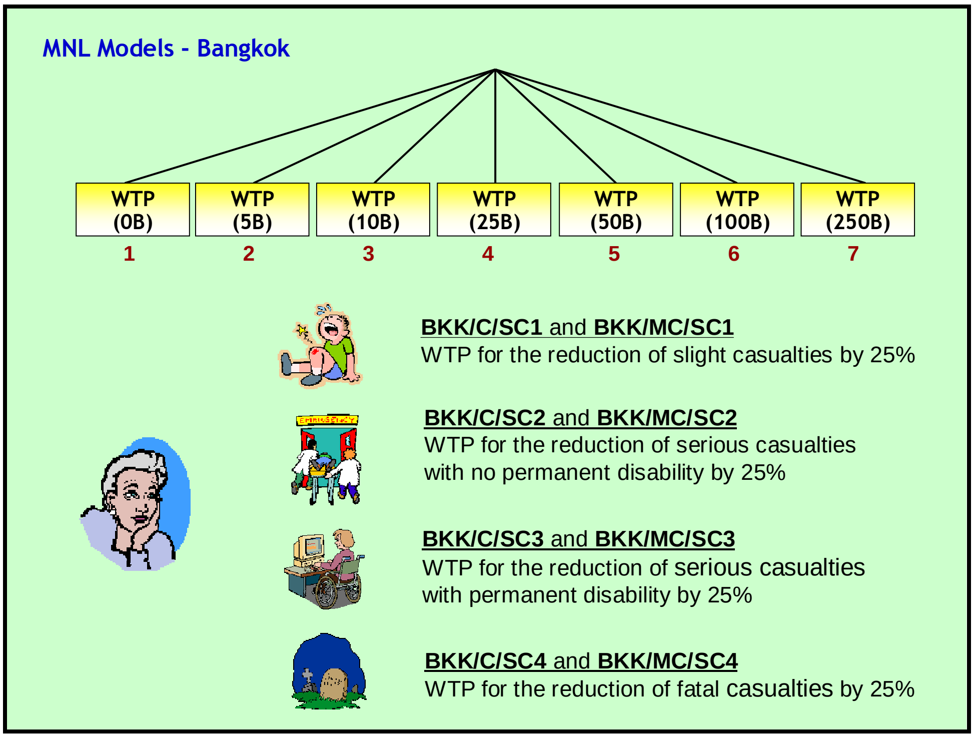


Fig. 19 MNL Model Structure for Bangkok

The MNL structures for Kuala Lumpur and Surabaya consist of eight and seven choice options (see figure 20 and 21). The respondents have been requested to select the best option for them out of the alternatives provided. Similar to the case of Bangkok, eight models were developed for each city to investigate the social attitudes and their WTP for the reduction of car and motorcycle casualties by 25%.

Models for Kuala Lumpur:
Car: KL/C/SC1, KL/C/SC2, KL/C/SC3, and KL/C/SC4
Motorcycle: KL/MC/SC1, KL/MC/SC2, KL/MC/SC3, and KL/MC/SC4

Models for Surabaya:
Car: SU/C/SC1, SU/C/SC2, SU/C/SC3, and SU/C/SC4
Motorcycle: SU/MC/SC1, SU/MC/SC2, SU/MC/SC3, and SU/MC/SC4

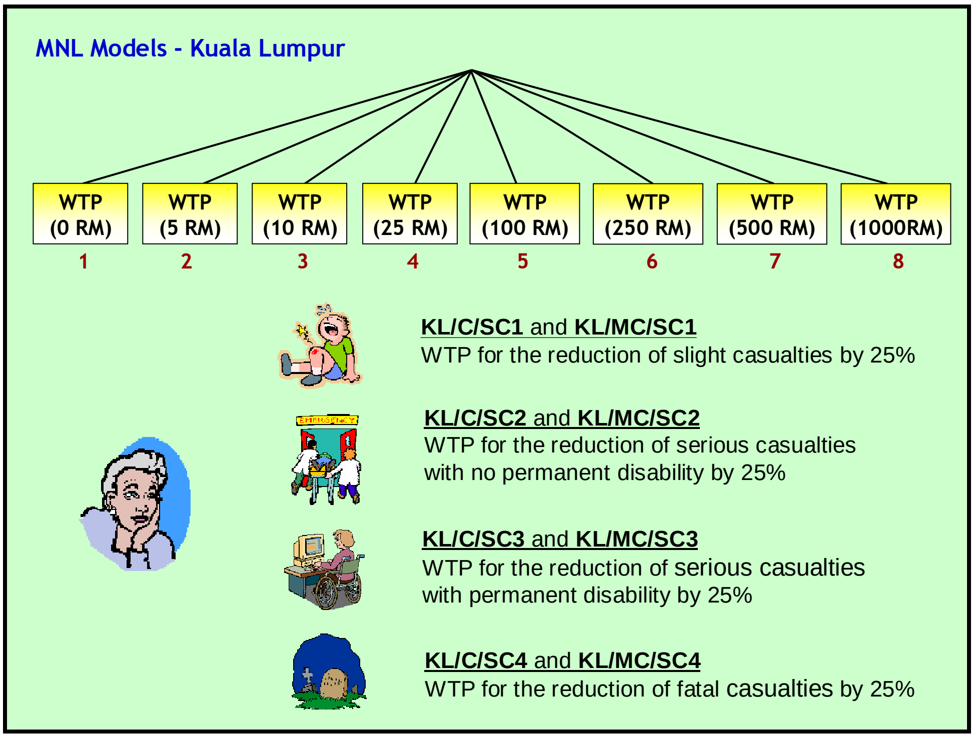


Fig. 20 MNL Model Structure for Kuala Lumpur

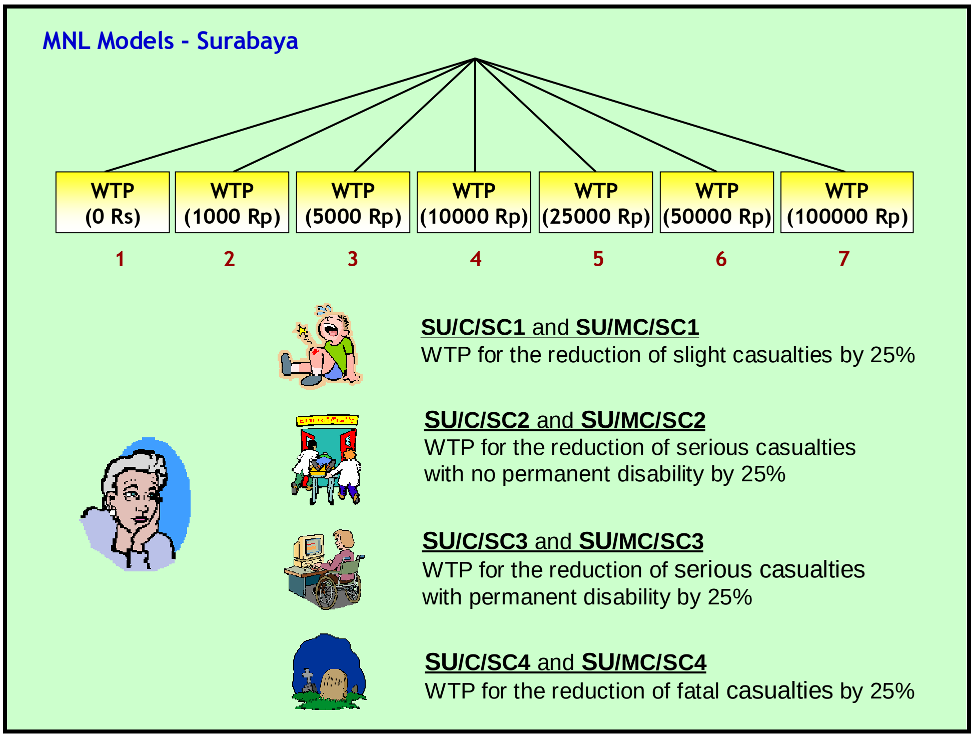


Fig. 21 MNL Model Structure for Surabaya

7.3 Results and Discussion

7.3.1 Attributes Tested in the Models

The respondents WTP decisions over casualty-risk reduction are expected to be contingent upon their age, gender, education, occupation, income, savings, marital status, number of children, vehicle ownership, modes used for daily travel, and road casualty experiences in the past and therefore the models were developed to enumerate those relationships. The databases from Bangkok, Kuala Lumpur, and Surabaya contain all the appropriate attributes that are to be tested in the models. In particular, the attributes that have been selected for modelling were of three main types:

- Alternative specific constants,
- Socio-economic variables (eg. age, gender, education, income, and vehicle ownership), and
- Alternative specific dummies (eg. individual, household, community related casualty experiences).

The proposed models in this project were aimed at investigating the social attitudes to WTP for casualty risk reductions by 25% over all severity classes (SC1, SC2, SC3, and SC4). The MNL models were estimated for Bangkok, Kuala Lumpur, and Surabaya using *the GAUSS software* and *the coded Gauss Databases* for each case study city. In order to make the inter-regional comparison easier, models were basically estimated with the same set of explanatory variables. Some of the variables not estimated significantly were kept in the models for comparison purposes. The MNL models developed for Bangkok, Kuala Lumpur, and Surabaya have seven, eight, and seven value (or utility) functions respectively. For example, the value functions for Bangkok represent the choices of WTP0, WTP5, WTP10, WTP25, WTP50, WTP100, and WTP250. The estimation results are presented in tables 6-11. The results obtained for Bangkok Car Models (table 6) are discussed below.

7.3.2 Discussion: Bangkok Car Models

The alternative specific constant (ASC) of the WTP250 value function was initially set to zero in all Bangkok Car models (see table 6) as per the requirement of the model estimation; all other ASCs associated to with the WTP0, WTP5, WTP10, WTP25, WTP50, and WTP100 value functions (choice options) were estimated. In the BKK/C/SC1 and BKK/C/SC2 models, the ASCs of some value-functions [WTP0, WTP5, WTP10, WTP50, and WTP100] are significant and positive indicating the respondents' preference for those choices over WTP250, which was considered as the base, for reducing the risk of SC1 and SC2. For the model BKK/C/SC3, the ASCs for the WTP10, WTP50, and WTP100 value-functions are significant and positive showing the respondents' propensity for paying 10B, 50B, and 100B for reducing SC3. The parameters of the BKK/C/SC4 model reveal the respondents' attitudes to reducing fatal casualties [SC4]. The negative and significant ASC of the WTP5 value function in the BKK/C/SC4 model indicates that the respondents are less likely to pay as little as 5B for the reduction of fatal casualties. Instead, they prefer paying 10B, 50B, or 100B as the ASCs of the WTP10, WTP50, and WTP100 value-functions are positive and significant.

From the results, it is also understood that when the level of severity of the casualty increases, the choice of 0B (WTP0) decreases. This is clear by observing the ASCs (5.72, 2.25, 0.65, 0.14) for WTP0 in all Bangkok Car Models. When the WTP at lower levels, especially 5B and 10B, is considered, the ASCs decrease with the increasing level of severity of the casualty. For fatal casualties (see BKK/C/SC4), the constant term gradually increases from WTP10 to WTP100 indicating the social attitude on the payment selection.

In all Bangkok Car Models, the attributes of age, gender, income, savings, education, number of children, and car ownership have been analysed to examine their association with the WTP for casualty risk reduction. Among them, only income, education, and car ownership were selected to remain in the models considering their appropriateness and importance to reveal the social attitudes to WTP. The income attribute does not however provide significant estimates in the Bangkok Car Models. But it certainly plays a significant contribution to all other models estimated (tables 7-11). Income may have considerable colinearity effects with education and this could be the reason for not having both income and education parameters significant. With the estimation results, it is unlikely to draw a conclusion that good (poor) income as well as good (poor) education will result in high (low) WTP for casualty risk reduction. However it is reasonable to assume that people in Bangkok are willing to pay for the reduction of risk over car related casualties regardless of their income and the level of education. Figure 2 may support this thought as the fatality risk in Thailand is extremely high and the people there comprehend the importance of road safety. The negative and significant parameter for car ownership in the BKK/C/SC1 model explains that when household car ownership increases, the WTP for slight casualty risk reduction decreases. This seems sensible as car owners are less exposed to becoming slight casualties compared to pedestrians, motorcyclists, and cyclists.

Several dummy variables related to the past casualty experiences of individuals', their households' (spouse or children), and their close communities' (parents, siblings, relatives, or friends) were tested in the models as they may have some relationship to their WTP choices. When an individual has any kind of casualty experience [SC1-4] at a personal or household or community level, the chances of selecting WTP0, in other words paying 0B, for the risk reduction of SC1 and SC2 are unlikely. This is clearly explained by the negative and significant parameters (-0.92 and -0.76) related to the BKK/C/SC1 and BKK/C/SC2 models. An individual who has an experience of SC2 at either a personal or household level, chooses to pay a significant amount such as 100B (WTP100) for reducing the risk of slight [SC1] as well as serious casualties [SC2 and SC3]; this is explained by the positive and significant parameters for the related dummy variable in the BKK/C/SC1, BKK/C/SC2, and BKK/C/SC3 models (2.14, 2.35, 1.38). An individual who suffered from either SC2 or SC3 at a personal or household or community level, has a strong attitude to pay at a higher level (WTP250) for all casualties [SC1, SC2, SC3, and SC4]; positive and highly significant parameters (3.57, 3.06, 2.24, 2.63) in all models assist this understanding.

7.3.3 A Summary: All Models Developed for Bangkok, Kala Lumpur, and Surabaya

<u>Alternative Specific Constants</u>

- When the level of severity of the casualty increases, the choice of 0B (WTP0) decreases. [see BKK/C (table 6), BKK/MC (table 7), KL/C (table 8), KL/MC (table 9), and SU/C (table 10) models]

- When the WTP at lower levels (WTP5, WTP10, WTP25 and WTP50 for Bangkok; WTP5, WTP10, WTP25, WTP100 for Kuala Lumpur) is considered, the constant term decreases with the increasing the level of severity. [see BKK/C (table 6), BKK/MC (table 7), KL/C (table 8), and KL/MC (table 9) models]

Socio-Economic Variables

- Income, education and motorcycle/car ownership are found as appropriate explanatory variables to explain the socio-economic status of the respondents and their relation to WTP in Bangkok models (table 6 and 7). When the level of education increases, the level of payment (WTP5, WTP10...WTP250) increases (see table 6: BKK/C/SC1 and table 7: all BKK/MC models]. When the household car ownership increases, the WTP for slight casualty [SC1] risk reduction decreases (see table 6: BKK/C/SC1 model).
- For Kuala Lumpur Car and Motorcycle models, income and age are found as appropriate explanatory variables to explain the socio-economic status of the respondents and their relation to WTP (table 8 and 9). When income increases, the WTP increases for both SC1 and SC2. Also when age increases, the WTP over car casualties increases for SC1 (see table 8: KL/C/SC1). In contrast, when age increases, the WTP over motorcycle casualties decreases for all casualty types (see table 9).
- Income and education are found as appropriate explanatory variables to explain the socio-economic status of the respondents and their relation to WTP in Surabaya models (table 10 and 11). When income increases, the WTP increases for the reduction of car and motorcycle casualties (see table 10 and 11). When the level of education increases, the WTP for car casualty increases (see table 10: SU/C/SC1, SU/C/SC2 and SU/C/SC3 models). On the contrary, regarding the risk reduction of motorcycle casualties, when the level of education increases, the WTP decreases (table 11: SU/MC/SC1 and SU/MC/SC2).

Alternative Specific Dummies

- When an individual has any type of casualty experience at a personal or household or community level, the chances of selecting WTP0 (no WTP) is unlikely (see BKK/C (table 6), BKK/MC (table 7), KL/C (table 8), KL/MC (table 9), SU/MC (table 11)).
- Even though the casualties happened long ago (>10 years ago) at a personal or household or community level, the respondents may not forget those incidents (see SU/MC (table 11) models). Their casualty experiences may persuade them not to select WTP0; negative parameters for the relevant dummy in SU/MC models explain this clearly (WTP0).
- When an individual has some past experiences in serious casualties [SC2] at either a personal or household level, chooses to pay a significant amount (for example 100B) for reducing the casualty risk (see table 6: BKK/C/SC1, BKK/C/SC2, and BKK/C/SC3; and table 7: BKK/MC/SC2, and BKK/MC/SC3).
- An individual who experienced either SC3 or SC4 at a personal or household or community level, has a strong attitude to pay a large amount (250B for Bangkok and RM100-1000 for Malaysia) for all casualty types to reduce the risk. This is equally applicable for Bangkok and Kuala Lumpur (see table 6 (all Bangkok Car models), table 7 (all Bangkok Motorcycle models, table 8 (KL/C/SC3 and KL/C/SC4) and table 9 (KL/MC/SC3 and KL/MC/SC4)).
- When an individual and his/her household members have past casualty experience in any kind of casualty [SC1-4], his/her WTP is very high (Rp. 25,000 - 250,000 for Surabaya) for all casualty types to reduce the risk (see table 10 (all Surabaya Car models) and table 11 (Surabaya Motorcycle models)).
- An individual who experienced either SC2 or SC3 or SC4 at a personal or household or community level, has a strong attitude to pay a significant sums (Rp 10,000-250,000 for Surabaya) for all casualty types to reduce the risk (see table 10 and table 11).

Table 6: Estimation Results – Bangkok Car Models [BKK/C/SC1, BKK/C/SC2, BKK/C/SC3, BKK/C/SC4]

Variable	BKK/C/SC1		BKK/C/SC2		BKK/C/SC3		BKK/C/SC4	
	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.
Alternative Specific Constants								
WTP 0 <alt. 1>	**5.72**	5.22	**2.25**	2.84	0.65	0.82	0.14	0.19
WTP 5 <alt. 2>	**3.97**	3.94	**2.09**	3.96	0.24	0.55	**-1.07**	-2.26
WTP 10 <alt. 3>	**4.67**	4.65	**3.28**	6.44	**2.28**	6.52	**1.28**	4.67
WTP 25 <alt. 4>	1.74	1.61	0.77	1.27	0.59	1.43	-0.67	-1.62
WTP 50 <alt. 5>	**3.38**	3.33	**2.77**	5.39	**2.03**	5.75	**1.53**	5.72
WTP 100 <alt. 6>	**2.40**	2.29	**1.70**	3.12	**1.75**	4.85	**1.50**	5.56
WTP 250 <alt. 7>	0.00	--	0.00	--	0.00	--	0.00	--
Socio-economic Variables								
Income/10^5, alts 2, 3, 4, 5, 6, 7	0.38	0.67	-0.58	-0.95	-1.04	-1.65	-1.00	-1.52
Education, alts 2, 3, 4, 5, 6, 7	**0.28**	2.80	-0.01	-0.15	-0.09	-0.55	-0.11	-0.67
Car ownership, alts 2, 3, 4, 5, 6, 7	**-0.30**	-2.22	-0.17	-1.08	-0.08	-0.48	0.00	-0.01
Alternative Specific Dummies								
SC1-4 experience <at personal or household or community level>, alt. 0	**-0.92**	-3.06	**-0.76**	-2.07	-0.34	-0.84	-0.55	-1.35
SC1-4 happened 10 yrs ago <at personal or household or community level>, alt. 0	0.37	0.83	0.11	0.19	0.16	0.27	0.26	0.43
SC2 <at personal or household level>, alt. 6	**2.14**	3.53	**2.35**	4.59	**1.38**	2.85	0.92	1.91
SC3 or SC4 <at personal or household or community level>, alt. 7	**3.57**	2.85	**3.06**	4.01	**2.24**	3.37	**2.63**	4.80
Summary statistics								
N	300		300		300		300	
L (**β**)	-443.18		-476.36		-498.67		-485.54	
L (**0**)	-583.77		-583.77		-583.77		-583.77	
ρ^2	0.24		0.18		0.15		0.17	

0 in Coef. column indicates a constant term set to zero.
-- in *t*-stat. column indicates *t*-stat. not available.
SC1- slight casualty
SC2- serious casualty but no permanent disability
SC3- serious casualty with permanent disability
SC4- fatal casualty

Table 7: Estimation Results – Bangkok Motorcycle Models [BKK/MC/SC1, BKK/MC/SC2, BKK/MC/SC3, BKK/MC/SC4]

Variable	BKK/MC/SC1		BKK/MC/SC2		BKK/MC/SC3		BKK/MC/SC4	
	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.
Alternative Specific Constants								
WTP 0 <alt. 1>	**5.59**	7.49	**4.06**	6.26	**3.57**	6.02	**2.64**	4.79
WTP 5 <alt. 2>	**2.54**	4.02	**1.10**	2.07	-0.33	-0.61	**-1.07**	-2.23
WTP 10 <alt. 3>	**3.02**	4.84	**2.63**	5.45	**1.88**	4.86	**0.72**	2.40
WTP 25 <alt. 4>	**2.64**	4.20	**2.18**	4.44	**1.56**	3.95	0.28	0.85
WTP 50 <alt. 5>	**1.85**	2.83	**1.89**	3.79	**1.77**	4.53	**0.99**	3.41
WTP 100 <alt. 6>	**2.64**	4.18	**2.40**	4.92	**2.14**	5.58	**1.74**	6.39
WTP 250 <alt. 7>	0.00	--	0.00	--	0.00	--	0.00	--
Socio-economic Variables								
Income/10^5, alts 2, 3, 4, 5, 6, 7	**1.47**	2.12	5.74	1.26	0.18	0.26	0.11	0.16
Education, alts 2, 3, 4, 5, 6, 7	**0.33**	3.71	**0.25**	2.57	**0.29**	2.77	**0.24**	2.23
MC ownership, alts 2, 3, 4, 5, 6, 7	**0.34**	2.00	0.34	1.64	0.34	1.58	**0.46**	1.96
Alternative Specific Dummies								
SC1-4 experience <at personal or household or community level>, alt. 0	-0.51	-1.63	-0.48	-1.41	**-0.68**	-1.96	**-0.73**	-1.99
SC1-4 happened 10 yrs ago <at personal or household or community level>, alt. 0	0.65	1.47	0.50	1.07	0.56	1.12	0.78	1.51
SC2 <at personal or household level>, alt. 6	0.29	0.55	**1.09**	2.65	**0.90**	2.23	0.63	1.57
SC1-4 <at both personal and household level>, alt. 7	**2.00**	2.10	1.50	1.72	0.95	1.14	0.89	1.39
SC3 or SC4 <at personal or household or community level>, alt. 7	**2.51**	2.60	**2.03**	2.30	**2.06**	2.80	**3.38**	5.58
Summary statistics								
N	298		298		298		298	
L (**β**)	-496.30		-514.32		-509.75		-487.13	
L (**0**)	-579.88		-579.88		-579.88		-579.88	
ρ^2	0.15		0.11		0.12		0.16	

0 in Coef. column indicates a constant term set to zero.
-- in *t*-stat. column indicates *t*-stat. not available.
SC1- slight casualty
SC2- serious casualty but no permanent disability
SC3- serious casualty with permanent disability
SC4- fatal casualty

Table 8: Estimation Results – Kuala Lumpur Car Models [KL/C/SC1, KL/C/SC2, KL/C/SC3, KL/C/SC4]

Variable	KL/C/SC1		KL/C/SC2		KL/C/SC3		KL/C/SC4	
	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.
Alternative Specific Constants								
Willingness-to-pay (0) <alt. 1>	**7.26**	6.42	**6.19**	6.16	**4.36**	4.55	**3.74**	4.01
Willingness-to-pay (5) <alt. 2>	**4.68**	5.62	**3.80**	5.79	**2.33**	6.73	**2.15**	6.68
Willingness-to-pay (10) <alt. 3>	**4.55**	5.46	**3.91**	5.96	**2.21**	6.34	**1.85**	5.67
Willingness-to-pay (25) <alt. 4>	**4.25**	5.09	**3.62**	5.49	**2.22**	6.38	**1.93**	5.94
Willingness-to-pay (100) <alt. 5>	**3.07**	3.66	**2.57**	3.87	**1.56**	4.52	**1.55**	4.87
Willingness-to-pay (250) <alt. 6>	**2.00**	2.28	**1.71**	2.46	0.69	1.82	**0.69**	1.97
Willingness-to-pay (500) <alt. 7>	0.69	0.80	0.51	0.70	0.00	0.00	0.00	0.00
Willingness-to-pay (1000) <alt. 8>	0.00	--	0.00	--	0.00	--	0.00	--
Socio-economic Variables								
Income/10^3, alts 2, 3, 4, 5, 6, 7, 8	**0.22**	2.37	**0.21**	2.23	0.01	0.11	0.02	0.19
Age, alts 2, 3, 4, 5, 6, 7, 8	**0.05**	1.99	0.04	1.74	0.05	1.88	0.04	1.44
Alternative Specific Dummies								
SC1-4 <at personal or household or community level>, alt. 0	**-1.56**	-3.64	**-1.42**	-3.30	**-1.72**	-3.75	**-1.69**	-3.72
SC1-4 happened 10 yrs ago <at personal or household or community level>, alt. 0	0.28	0.72	0.30	0.78	0.12	0.24	0.10	0.19
SC1-4 <at personal and household>, alt. 7, 8	1.04	1.26	0.53	0.72	-0.19	-0.35	-0.16	-0.34
SC3 or SC4 <at personal or household or community level>, alts 5, 6, 7, 8	0.60	1.84	0.42	1.38	**0.62**	2.57	**0.50**	2.16
Summary statistics								
N	400		400		400		400	
L (**β**)	-645.84		-670.74		-725.16		-741.62	
L (**0**)	-831.78		-831.78		-831.78		-831.78	
ρ^2	0.22		0.19		0.13		0.11	

0 in Coef. column indicates a constant term set to zero.
-- in *t*-stat. column indicates *t*-stat. not available.
SC 1- slight casualty
SC 2- serious casualty but no permanent disability
SC 3- serious casualty with permanent disability
SC 4- fatal casualty

Table 9: Estimation Results – Kuala Lumpur Motorcycle Models [KL/MC/SC1, KL/MC/SC2, KL/MC/SC3, KL/MC/SC4]

Variable	KL/MC/SC1		KL/MC/SC2		KL/MC/SC3		KL/MC/SC4	
	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.
Alternative Specific Constants								
Willingness-to-pay (0) <alt. 1>	**2.62**	2.23	1.54	1.48	0.14	0.15	0.04	0.05
Willingness-to-pay (5) <alt. 2>	**4.13**	5.42	**3.01**	5.88	**1.76**	5.44	**1.29**	4.70
Willingness-to-pay (10) <alt. 3>	**4.05**	5.31	**3.23**	6.35	**2.10**	6.59	**1.53**	5.65
Willingness-to-pay (25) <alt. 4>	**3.26**	4.24	**2.47**	4.78	**1.52**	4.64	**1.40**	5.13
Willingness-to-pay (100) <alt. 5>	**2.29**	2.91	**1.68**	3.14	**1.00**	2.91	**0.82**	2.86
Willingness-to-pay (250) <alt. 6>	0.81	0.92	0.71	1.22	-0.34	-0.80	-0.32	-0.89
Willingness-to-pay (500) <alt. 7>	-0.92	-0.75	0.34	0.55	-0.41	-0.90	-0.75	-1.88
Willingness-to-pay (1000) <alt. 8>	0.00	--	0.00	--	0.00	--	0.00	--
Socio-economic Variables								
Income/10^3, alts 2, 3, 4, 5, 6, 7, 8	**0.24**	2.97	**0.22**	2.74	**0.20**	2.49	**0.22**	2.55
Age, alts 2, 3, 4, 5, 6, 7, 8	**-0.04**	-2.00	**-0.04**	-2.35	**-0.06**	-2.88	**-0.05**	-2.47
Alternative Specific Dummies								
SC1-4 <at personal or household or community level>, alt. 0	**-1.56**	-3.64	**-1.42**	-3.30	**-1.72**	-3.75	**-1.69**	-3.72
SC1-4 happened 10 yrs ago <at personal or household or community level>, alt. 0	0.28	0.72	0.30	0.78	0.12	0.24	0.10	0.19
SC1-4 <at personal and household level>, alt. 7, 8	1.04	1.26	0.53	0.72	-0.19	-0.35	-0.16	-0.34
SC3 or SC4 <at personal or household or community level>, alts 5, 6, 7, 8	0.60	1.84	0.42	1.38	**0.62**	2.57	**0.50**	2.16
Summary statistics								
N	400		400		400		400	
L (**β**)	-601.20		-654.80		-699.21		-732.47	
L (**0**)	-831.78		-831.78		-831.78		-831.78	
ρ^2	0.28		0.21		0.16		0.12	

0 in Coef. column indicates a constant term set to zero.
-- in *t*-stat. column indicates *t*-stat. not available.
SC1- slight casualty
SC2- serious casualty but no permanent disability
SC3- serious casualty with permanent disability
SC4- fatal casualty

Table 10: Estimation Results – Surabaya Car Models [SU/C/SC1, SU/C/SC2, SU/C/SC3, SU/C/SC4]

Variable	SU/C/SC1		SU/C/SC2		SU/C/SC3		SU/C/SC4	
	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.
Alternative Specific Constants								
Willingness-to-pay (0) <alt. 1>	**8.40**	7.93	**6.66**	7.84	**5.92**	7.15	**3.57**	7.08
Willingness-to-pay (1000) <alt. 2>	**4.46**	6.01	**1.14**	2.88	**-0.18**	**-0.47**	**1.17**	2.08
Willingness-to-pay (5000) <alt. 3>	**4.90**	6.64	**2.82**	8.38	**1.46**	5.31	**2.58**	5.27
Willingness-to-pay (10000) <alt. 4>	**3.93**	5.40	**2.38**	7.47	**1.88**	7.95	**2.84**	6.08
Willingness-to-pay (25000) <alt. 5>	**2.97**	4.10	**1.81**	5.80	**1.18**	5.05	**3.13**	6.84
Willingness-to-pay (50000) <alt. 6>	**1.79**	2.35	0.56	1.55	0.38	1.42	**2.42**	5.18
Willingness-to-pay (100000) <alt. 7>	**0**	--	**0**	--	**0**	**--**	**2.08**	4.38
Willingness-to-pay (250000) <alt. 8>	**--**	--	**--**	--	**--**	**--**	**0**	--
Socio-economic Variables								
Income/10^6, alts 2, 3, 4, 5, 6, 7, 8$^{\beta}$	**0.10**	2.12	**0.10**	2.04	**0.10**	2.00	**0.11**	2.21
Education, alts 2, 3, 4, 5, 6, 7, 8$^{\beta}$	**0.93**	4.38	**1.01**	4.63	**1.02**	4.65	**--**	**--**
Alternative Specific Dummies								
SC1-4 <at personal and household level>, alts 5, 6, 7, 8$^{\beta}$	**0.64**	2.09	**0.63**	2.62	**0.68**	2.99	**0.48**	2.10
SC2 or SC3 or SC4 <at personal or household or community level>, alts 4, 5, 6, 7, 8$^{\beta}$	**0.98**	4.23	**0.82**	3.97	**0.71**	3.31	**0.63**	2.87
Summary statistics								
N	414		414		414		414	
L (**β**)	-660.55		-680.04		-692.64		-750.23	
L (**0**)	-805.61		-805.61		-805.61		-860.89	
ρ^2	0.18		0.16		0.14		0.13	

0 in Coef. column indicates a constant term set to zero.
-- in Coef. column and -- in *t*-stat. column indicates parameter not estimated and *t*-stat. not calculated respectively.
SC1- slight casualty
SC2- serious casualty but no permanent disability
SC3- serious casualty with permanent disability
SC4- fatal casualty
β considered only for CAR-FATAL Model only

Table 11: Estimation Results – Surabaya Motorcycle Models [SU/MC/SC1, SU/MC/SC2, SU/MC/SC3, SU/MC/SC4]

Variable	SU/MC/SC1		SU/MC/SC2		SU/MC/SC3		SU/MC/SC4	
	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.	Coef.	*t*-stat.
Alternative Specific Constants								
Willingness-to-pay (0) <alt. 1>	**3.54**	5.14	**3.88**	5.65	**4.20**	5.82	**3.35**	4.81
Willingness-to-pay (1000) <alt. 2>	**2.61**	6.49	**2.83**	7.04	**2.82**	6.08	**1.65**	4.05
Willingness-to-pay (5000) <alt. 3>	**2.71**	6.75	**3.31**	8.36	**3.60**	7.96	**2.45**	6.26
Willingness-to-pay (10000) <alt. 4>	**2.02**	5.45	**2.67**	7.15	**3.12**	7.18	**2.33**	5.71
Willingness-to-pay (25000) <alt. 5>	0.00	--	**1.63**	4.48	**2.12**	4.91	**1.46**	3.47
Willingness-to-pay (50000) <alt. 6>	--	--	0.00	--	0.92	1.90	0.77	1.73
Willingness-to-pay (100000) <alt. 7>	--	--	--	--	0.00	--	0.00	--
Socio-economic Variables								
Income/10^6, alts 2, 3, 4, 5, 6^{γ}, 7^{δ}	**0.30**	3.12	**0.24**	2.47	**0.22**	2.31	**0.25**	2.41
Education, alts 2, 3, 4, 5, 6^{γ}, 7^{δ}	**-0.02**	-2.41	**-0.02**	-2.00	-0.02	-1.89	-0.02	-1.72
Alternative Specific Dummies								
SC 1-4 <at personal and household level>, alt. 0	-0.94	-1.88	-0.92	-1.84	**-0.92**	2.32	**-1.09**	-2.17
SC 1-4 happened 10 yrs ago <at personal or household or community level>, alt. 0	**-2.12**	-3.49	**-1.84**	-3.01	-1.81	-1.88	**-1.71**	-2.79
SC 1-4 <at personal and household level>, alt. 5, 6^{θ}, 7^{ξ}	**1.24**	2.66	**0.72**	2.41	**0.67**	2.48	--	--
SC2 or SC3 or SC4 <at personal or household or community level>, alt 4, 5, 6^{π}, 7^{ξ}	**0.73**	2.95	**0.78**	3.52	**0.70**	3.31	**0.57**	2.76
SC3 or SC4 <at personal or household or community level>, alt 7	--	--	--	--	--	--	**1.73**	3.12
Summary statistics								
N	431		431		431		431	
L (**β**)	-617.27		-676.88		-706.95		-736.62	
L (**0**)	-693.67		-772.25		-838.69		-838.69	
ρ^2	0.11		0.12		0.16		0.12	

0 in Coef. column indicates a constant term set to zero.
-- in *t*-stat. column indicates parameter not estimated and *t*-stat. not calculated respectively.
SC1- slight casualty
SC2- serious casualty but no permanent disability
SC3- serious casualty with permanent disability
SC4- fatal casualty
γ considered for the models MC- SC2
δ considered for the models MC- SC2 and MC- SC$
θ considered for the models MC- SC2 and MC- SC3
ξ considered for the model MC- SC3
π considered for the model MC- SC2 and MC- SC4

8. SAFETY VALUATION

8.1 Application of the DCM to Estimate the Value of Statistical Life (*VSL*)

The outputs of the developed models (tables 6-11) have been employed to value road casualties. The procedure consists of two main steps:

- Calculation of the Mean WTP
- Estimation of the *VSL*

<u>STEP 1</u>: Calculation of the Mean WTP

$$\overline{W} = \sum_{n=1}^{N} \left[\sum_{i} P_n(i) W(i) \right] \Big/ \mathrm{N} \qquad (7)$$

N = total number of individuals in the database
$W(i)$ = WTP choice option i
$Pn(i)$ = probability that alt. i is chosen by individual n
$\overline{W}$ = mean willingness-to-pay per individual

The mean WTP values for all case study areas are presented in table 12 below:

Table 12 Mean WTP Values Obtained from the Models

Case Study		Mean WTP ($\overline{W}$)			
		SC1	SC2	SC3	SC4
Thailand (in B)	Car	18	33	48	65
	MC	28	40	50	61
Malaysia (in RM)	Car	32	40	78	90
	MC	26	44	80	99
Indonesia (in Rp)	Car	7826	13627	18491	28662
	MC	4790	7474	9900	13008

<u>STEP II</u>: Estimation of the *VSL*

People whose lives are saved by a safety improvement cannot be identified in advance. Therefore, to measure the value of reducing risks in a population, the concept of statistical life is used. In contingent valuation studies, the value of a statistical life is equal to the mean willingness to pay divided by the reduced risk of casualty. According to Kochi et al. [2001], the following equation is proposed to calculate the WTP contribution towards the total *VSL*:

$$V(WTP) = \frac{\text{Mean WTP per individual to avoid risk}}{\text{Change in statistical risk}} = \frac{\overline{W}}{\beta} \qquad (8)$$

$V(WTP)$ = the WTP component towards the total *VSL*
β = change in statistical risk

Using the casualty statistics from three case study areas stated below and the mean WTP values from table 12, the *V(WTP)* for car and motorcycle casualties SC1-SC4 are obtained (see table 13).

Casualty Statistics Thailand

The additional information for the analysis is taken from ADB-CR9 [2005] as follows:
Death rate in 2002 = 20.9 deaths per 100,000 population
Number of cars involved in road accidents in 2002 = 44,019
Number of motorcycles involved in road accidents in 2002 = 53,732

Casualty Statistics Malaysia

The additional information for the analysis is taken from ADB-CR5 [2005] as follows:
Number of cars involved in fatal injuries in 2003 = 1,502 (1,183+138+ 91+90)
Number of motorcycles involved in fatal injuries in 2003 = 3,548
Number of registered cars in 2003 = 5,426,026
Number of registered motorcycles in 2003 = 6,163,851

Casualty Statistics Indonesia

The additional information for the analysis is taken from ADB-AC3 [2005] as follows:
Number of fatal injuries in 2002 = 30,464
Number of cars involved in road accidents in 2002 = 8,666 (48%) = (4,306+1,654+2,706)
Number of motorcycles involved in road accidents in 2002 = 8,518 (47%)
Number of registered vehicles in 2002 = 24,671,330 =
(3,862,579+2,015,347+731,990+18,061,414)

As suggested by Mohan [2002], the casualty share over fatal, serious and slight categories is considered as 1:15:70. It is also considered that the fatal casualties that have been recorded by the police are correct, and can be used as the base of the calculation.

Table 13 *V(WTP)* for Car and Motorcycle Casualties in Thailand, Malaysia, and Indonesia

Case Study		*V(WTP)*			
		SC1	SC2	SC3	SC4
Thailand (in B)	Car	10,994	94,597	136,548	3,263,783
(2002 statistics used)	MC	13,787	92,216	116,412	2,038,306
Malaysia (in RM)	Car	6,686	38,380	75,219	1,294,996
(2003 statistics used)	MC	2,564	20,433	36,962	707,976
Indonesia (in Rp)	Car	754,555	6,131,255	8,319,532	193,433,170
(2002 statistics used)	MC	471,892	3,428,447	4,541,161	86,719,533

According to Evens [2006], the *VSL* cannot be fully represented only by the *V(WTP)* (table 13 values); it has to be a summation of the components of WTP, the net output and the direct cost. Therefore, the *VSL* is calculated using equation 5.

The lost gross output and the direct cost [*V(Gross Output)* and *V(Direct Cost)*] estimates are available for all three case study cities; however it is difficult to find the necessary information to quantify the net output [*V(Net Output)*], for instance the details related to per capita expenditure. Therefore this study assumes that the discounted lost consumption is 25% of the gross discounted lost lifetime output. In other words, *V(Net Output)* is considered to be equal to 75% of *V(Gross Output)*. Table 14 presents the cost components that are necessary to quantify *VSL* in the case study areas. The valuation results are shown in table 15.

Table 14 Cost Components: WTP, Net Output, and Direct Costs

Case Study		V(WTP)[a]				V(Net Output)[b,c]			V(Direct Cost)[c]		
		SC1	SC2	SC3	SC4	SC1	SC2/SC3	SC4	SC1	SC2/SC3	SC4
Thailand (in B)	Car	10,994	94,597	136,548	3,263,783	980	14690	1,616,708	19,477	69,030	161,275
	MC	13,787	92,216	116,412	2,038,306						
Malaysia (in RM)	Car	6,686	38,380	75,219	1,294,996	Not Available	Not Available	178,939	Not Available	Not Available	Not Available
	MC	2,564	20,433	36,962	707,976						
Indonesia (in Rp)	Car	754,555	6,131,255	8,319,532	193,433,170	4,561,589	16,024,454	245,503,789	5,118,657	12,705,157	19,655,157
	MC	471,892	3,428,447	4,541,161	86,719,533						

[a] Results from this study
[b] 75% of the discounted gross output figures
[c] *V(Net Output)* and *V(Direct Cost)* Figures are from ADB-AC9 [2007] for Thailand, from ESCAP [1985] for Malaysia and from ADB-AC3 [2007] for Indonesia.

Table 15 Estimated *VSL* for Thailand, Malaysia and Indonesia

Case Study		VSL				VSL (Average for Car and Motorcycle)			
		SC1	SC2	SC3	SC4	SC1	SC2	SC3	SC4
Thailand (in B)	Car	31,451	178,317	220,268	5,041,766	32,848	177,127	210,200	4,429,028
	MC	34,244	175,936	200,132	3,816,289				
Malaysia (in RM)	Car	6,686	38,380	75,219	1,473,935	4,625[d]	29,407[d]	56,091[d]	1,180,425[e]
	MC	2,564	20,433	36,962	886,915				
Indonesia (in Rp)	Car	10,434,801	34,860,866	37,049,143	458,592,116	10,293,470	33,509,462	35,159,958	405,235,298
	MC	10,152,138	32,158,058	33,270,772	351,878,479				

[d] *VSL* figures do not include the relevant components the lost net output [*V(NO)*] and the direct cost [*V(DC)*].
[e] *VSL* figure does not include the direct cost [*V(DC)*].

9. CONCLUSIONS AND RECOMMENDATIONS

The aim of the project is in two folds. Firstly, it attempts to investigate social attitudes to road safety risk reduction by modeling peoples' WTP. Secondly, the models developed were used to estimate the *VSL*. The lives that saved by safety improvements cannot be identified in advance. Therefore, the concept of statistical life is used in this study to measure the value of reducing risks in society.

The *Stated Preference (SP) Contingent Valuation Technique* is used to collect information from general public on road safety improvements. The *SP* questionnaire is designed to collect information including socio-economic data, personal, household and community based past casualty experiences and the WTP for the casualty risk reduction over slight, serious and fatal categories.

The novel *Discrete Choice Modelling Techniques* were employed in this study to analyse social attitudes to WTP on casualty risk reduction. It is found that income, education and vehicle ownership attributes have a significant relation with peoples' WTP in Thailand. For the case of Malaysia, income and age play a considerable part on peoples' WTP. Income and education show a substantial correlation with WTP in Indonesia. In all countries, individual, household and community related casualty experiences play a major part of peoples' WTP on casualty risk reduction.

According to the results (see table 15), it is found that the *VSL* from the WTP method is higher than the Human Capital method (table 1-3) for all countries. There is an existing study in Malaysia that used the WTP method to value casualties [Fauzi et al., 2004]. It is found that the value suggested by Fauzi et al. [2004] for fatal casualties (MR 1.1 million) is very similar to the *VSL* obtained from this study (MR 1.2 million). Since the direct cost estimates are not available in Malaysia, this study doesn't consider the direct cost component in the final cost estimates. Therefore the *VSL* estimates for fatal casualties in Malaysia (see table 15) could be slightly higher than suggested. It is also understood from the results that the casualty cost estimates in practice in Asian countries are far below the actual costs.

The MNL models developed can be extended over WTP predictions and this could be a future direction of this research study. This may help understand the variation of *VSL* due to the changes of income, education, and vehicle ownership in a country.

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APPENDIX A

Database Statistics

Bangkok: WTP Data for the Reduction of Car Casualties (BKK/C)

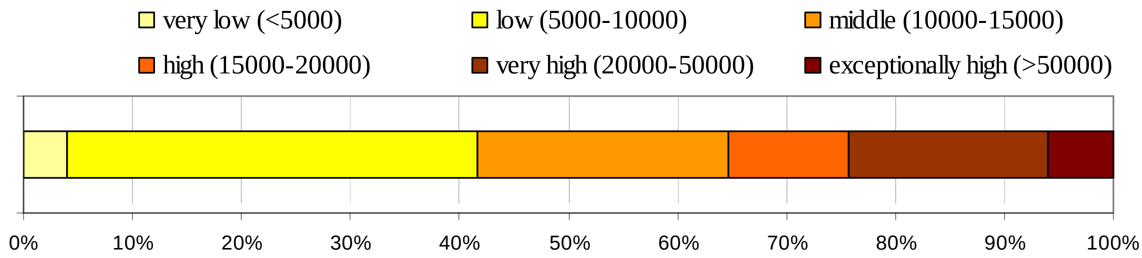

Fig. A1 Distribution of Income - BKK/C (Incomes are in Thai Baht)

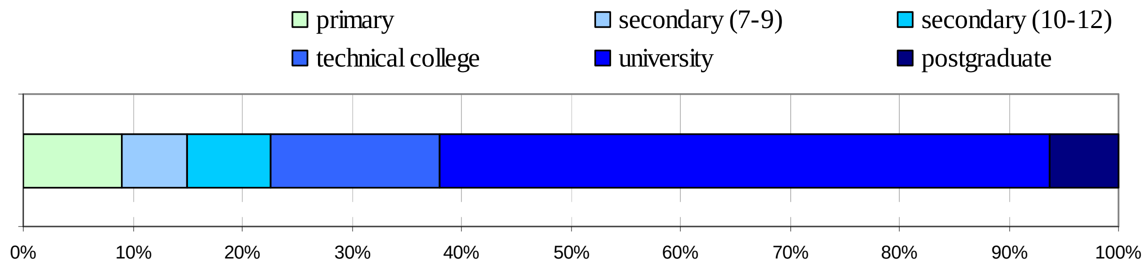

Fig. A2 Distribution of Respondent's Education - BKK/C

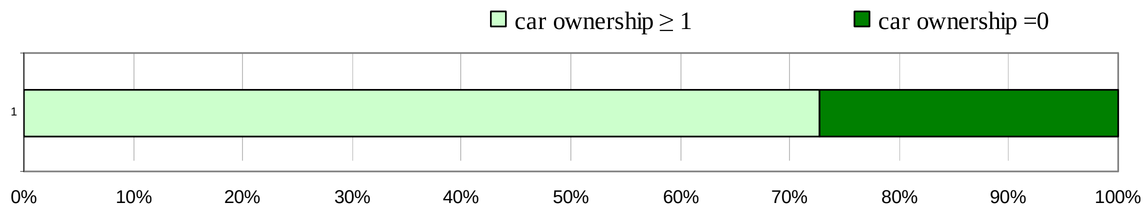

Fig. A3 Distribution of Household Car Ownership - BKK/C

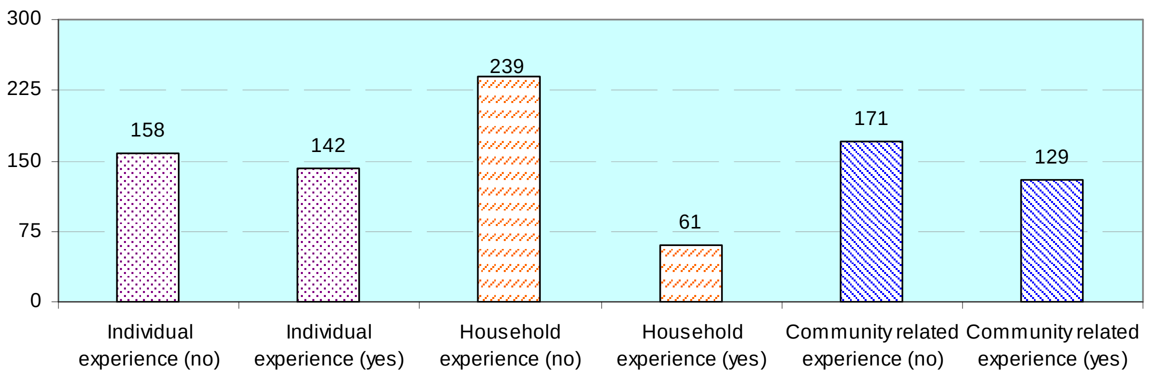

Fig. A4 – Casualty Experience - BKK/C

Bangkok: WTP Data for the reduction of Motorcycle Casualties (BKK/MC)

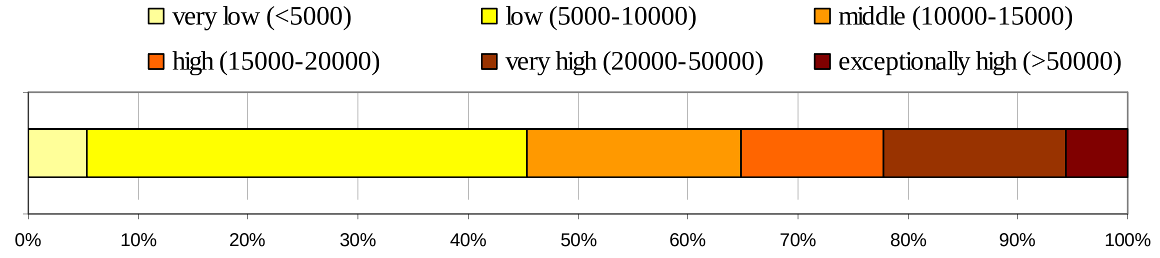

Fig. A5 Distribution of Income - BKK/MC (Incomes are in Thai Baht)

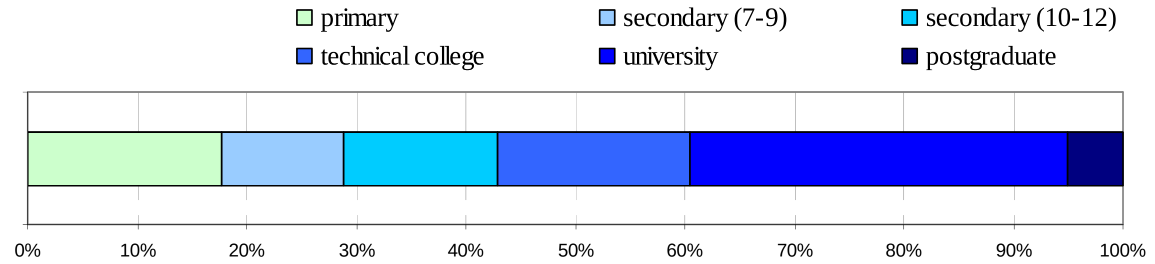

Fig. A6 Distribution of Respondent's Education - BKK/MC

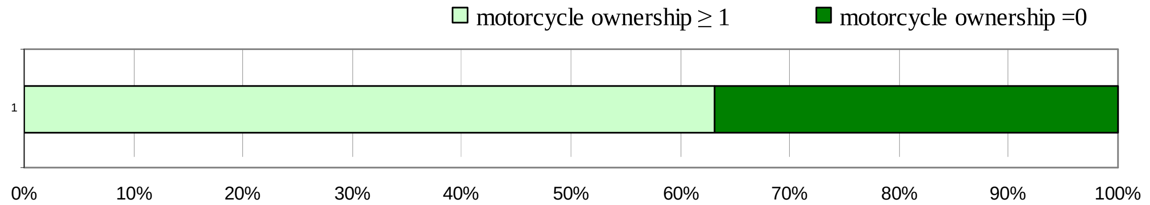

Fig. A7 Distribution of Household Motorcycle Ownership - BKK/MC

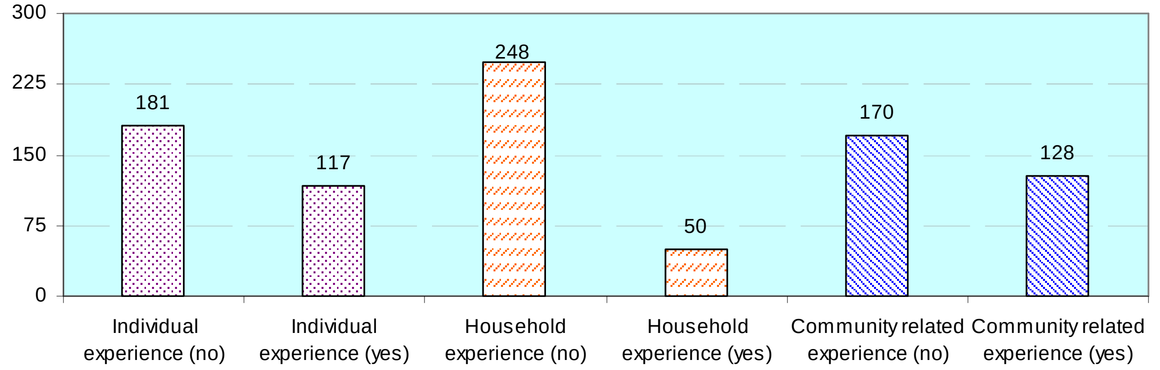

Fig. A8 – Casualty Experience - BKK/MC

Kuala Lumpur: WTP Data for the Reduction of Car Casualties (KL/C)

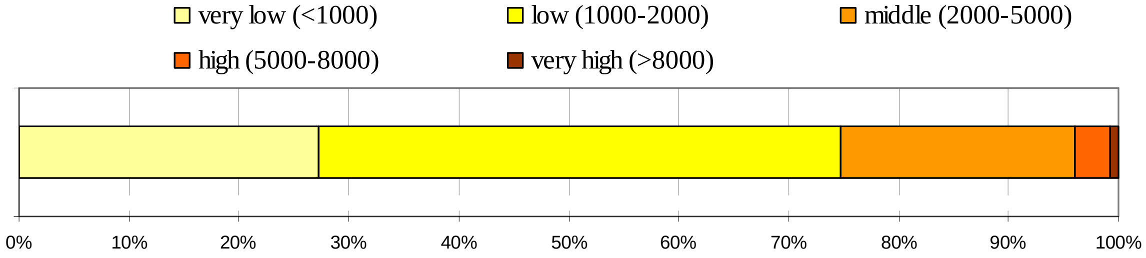

Fig. A9 Distribution of Income - KL/C (Incomes are in Malaysia Ringgits)

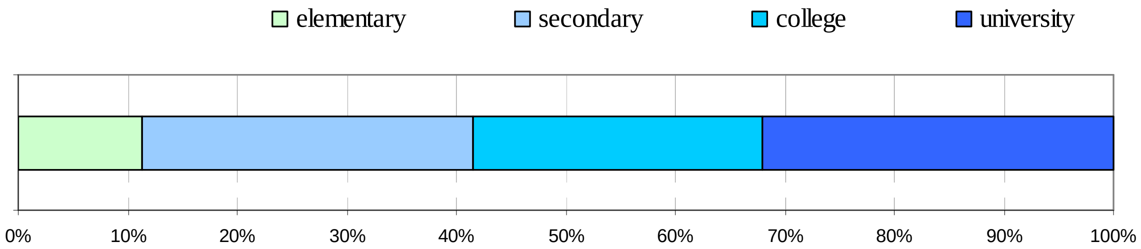

Fig. A10 Distribution of Respondent's Education - KL/C

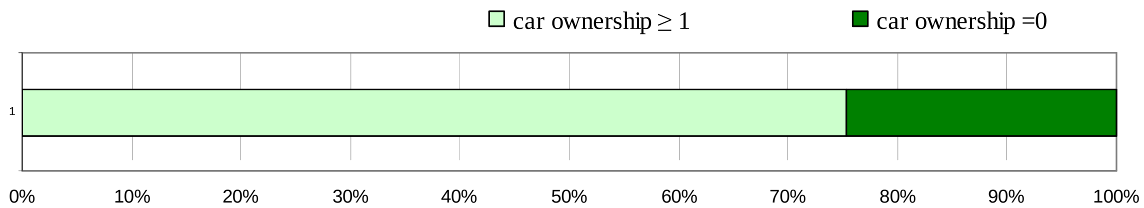

Fig. A11 Distribution of Household Car Ownership - KL/C

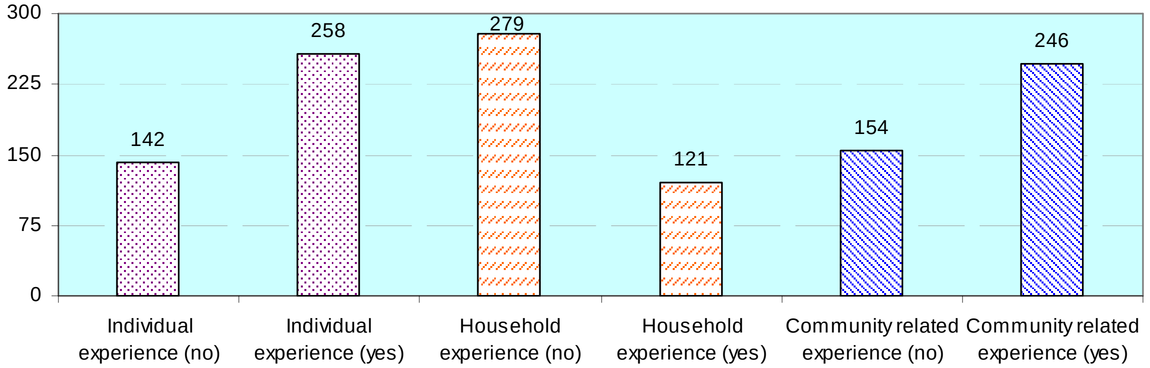

Fig. A12 – Casualty Experience - KL/C

Kuala Lumpur: WTP Data for the reduction of Motorcycle Casualties (KL/MC)

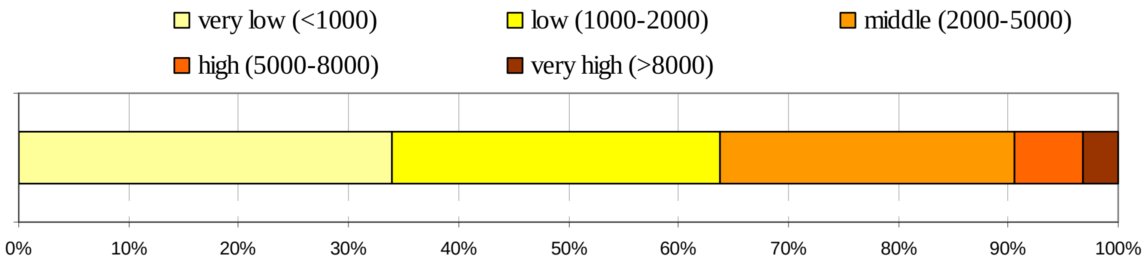

Fig. A13 Distribution of Income - KL/MC (Incomes are in Malaysia Ringgits)

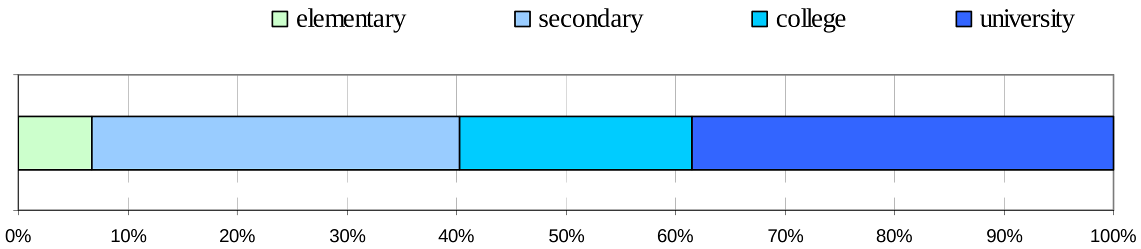

Fig. A14 Distribution of Respondent's Education - KL/MC

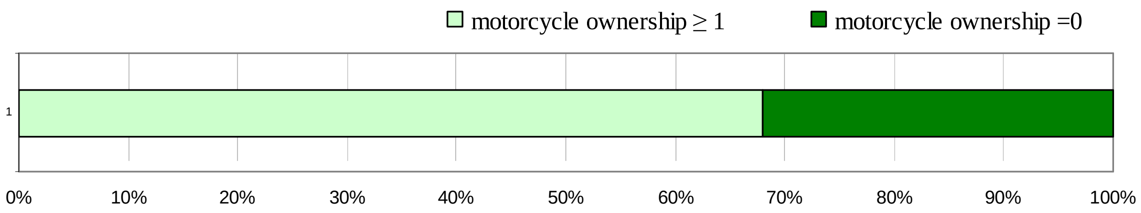

Fig. A15 Distribution of Household Motorcycle Ownership - KL/MC

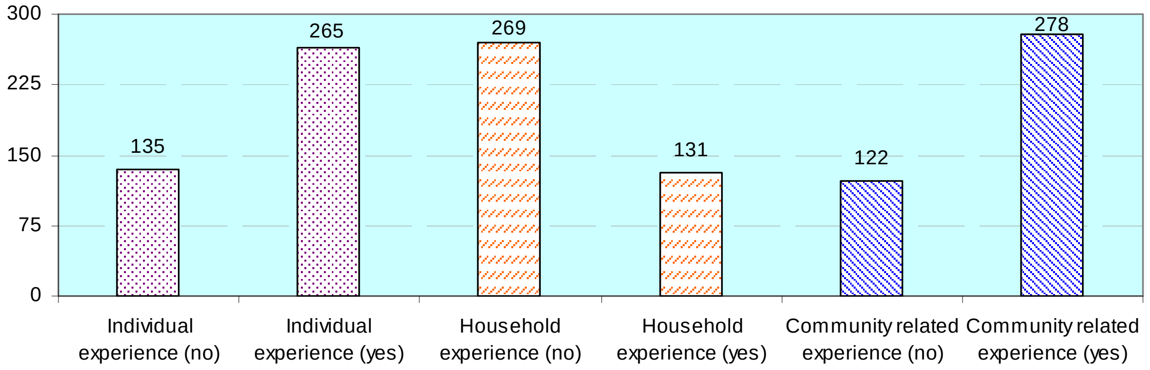

Fig. A16 – Casualty Experience - KL/MC

Surabaya: WTP Data for the Reduction of Car Casualties (SU/C)

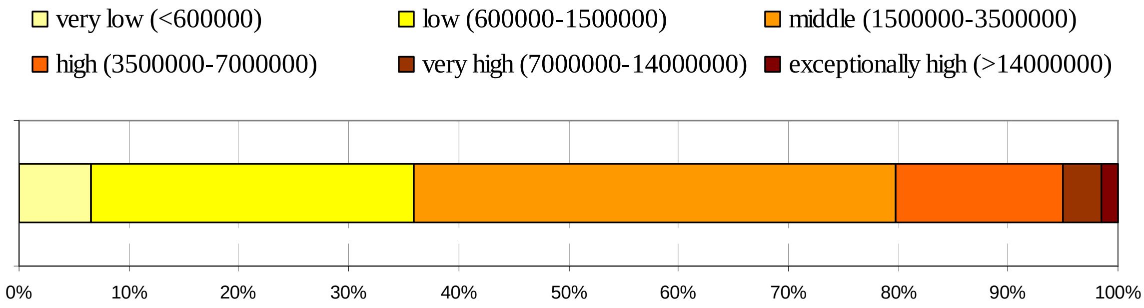

Fig. A17 Distribution of Income - SU/C (Incomes are in Indonesia Rupiahs)

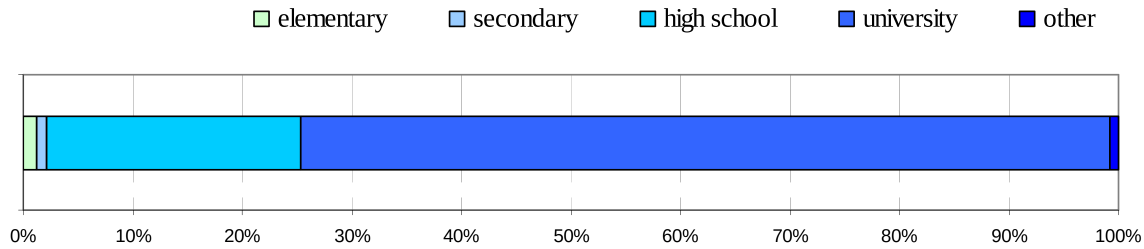

Fig. A18 Distribution of Respondent's Education -SU/C

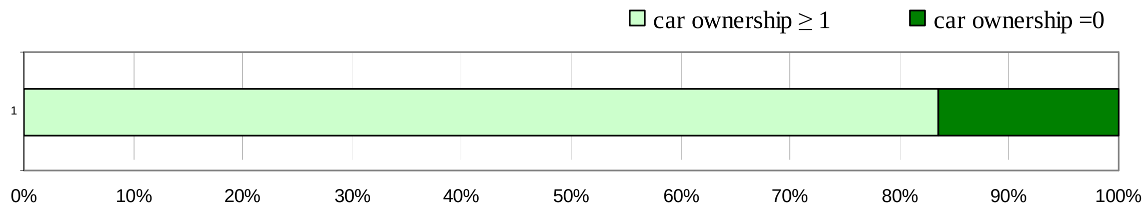

Fig. A19 Distribution of Household Car Ownership - SU/C

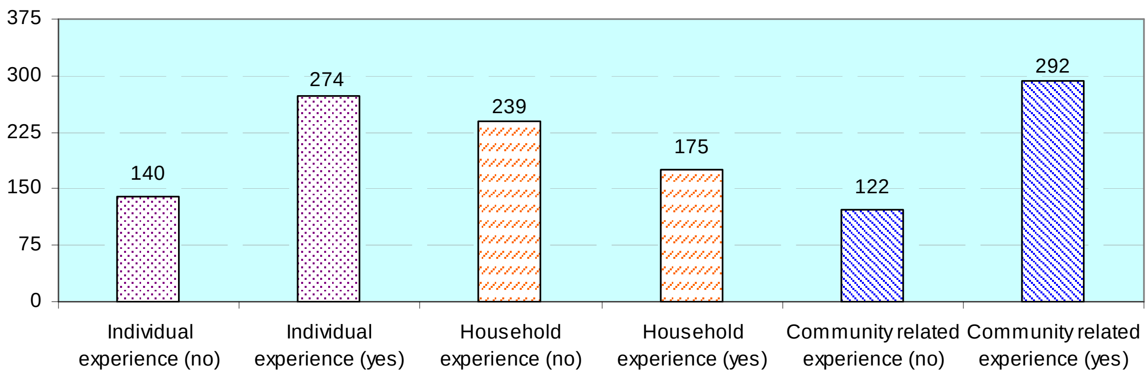

Fig. A20 – Casualty Experience - SU/C

Surabaya: WTP Data for the reduction of Motorcycle Casualties (SU/MC)

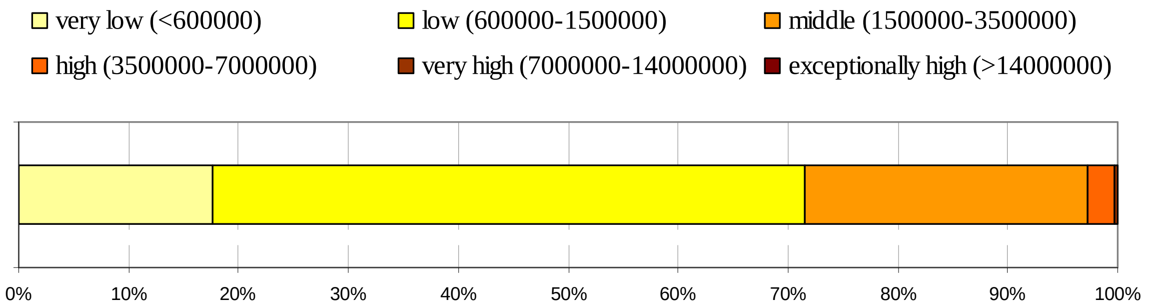

Fig. A21 Distribution of Income - SU/MC (Incomes are in Indonesia Rupiahs)

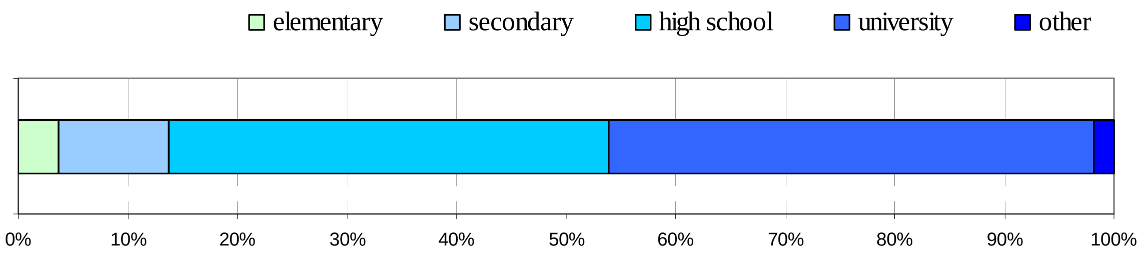

Fig. A22 Distribution of Respondent's Education - SU/MC

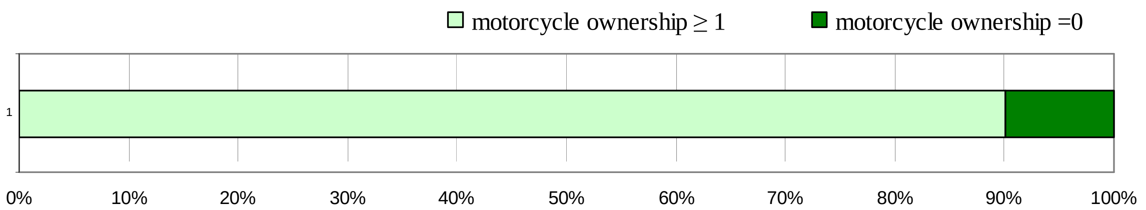

Fig. A23 Distribution of Household Motorcycle Ownership - SU/MC

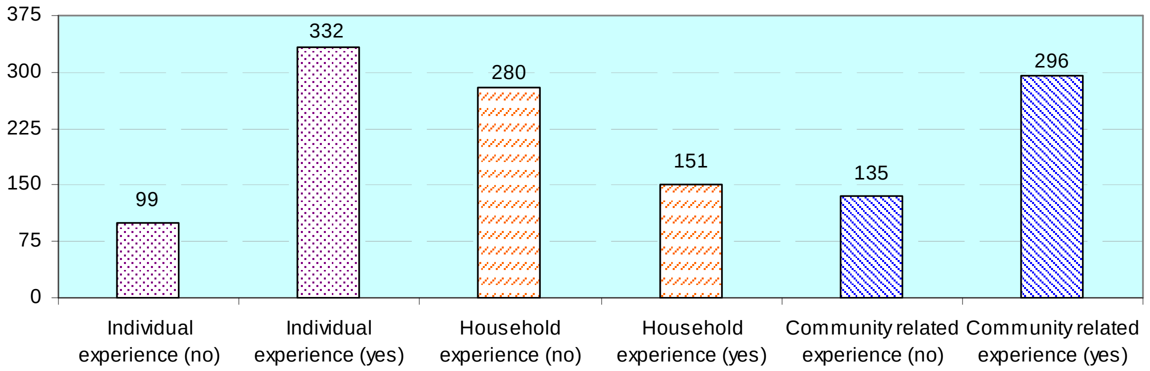

Fig. A24 – Casualty Experience - SU/MC