Valuing Motorcycle Casualties in Developing Countries using Willingness-to-Pay Method: Stated-Preference Discrete Choice Modelling Approach

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Abstract

Motorcycle ownership and use in developing cities in Asia, including Surabaya and Jakarta (Indonesia), Kuala Lumpur (Malaysia) and Bangkok (Thailand) have increased dramatically over the past few decades. With this high rate of growth, there is evidence of an increase in the number of motorcycle casualties. Currently, efforts to reduce road casualties in general, and to reduce motorcyclist casualties in particular, have attracted considerable attention in developing countries, especially where motorcycle casualties have risen rapidly, for instance, in Indonesia. Necessary road safety improvements will demand substantial funding which the respective local and regional authorities of the countries generally support. To provide information to policy makers, in particular on how much saving can be gained by implementing road safety improvements, it is very important to have an accurate technique for valuing a road casualty.

Various techniques are available to value road casualties however the appropriate method will depend on the objectives and balancing conflicting objectives such as whether to maximise the country's Gross Domestic Product (GDP) or strengthen social welfare. At present, most of the developing countries, including Indonesia, use the Gross Output method to value the casualties; the objective of this method is to maximise the GDP. On the other hand, most of the developed countries prefer to use the Willingness to Pay method, which combines welfare objectives with cost-benefit analysis. The cost-benefit analysis is needed on the valuation of safety improvement program. The Willingness to Pay method was devised to determine the value of preventing casualties and to strengthen the social welfare objectives. This research uses the Willingness to Pay method for valuing motorcyclist casualty costs. In order to investigate the similarities, differences and interaction between the two, the Gross Output method also is used to estimate the motorcycle casualty costs. The case study used for this research is Surabaya city in Indonesia where the number of motorcycle casualties has increased substantially since the early 1990s.

This study identifies that the Discrete Choice Modelling technique is appropriate to put a value of the Willingness to Pay. The study also delivers a basic understanding of the relationship between social attitudes and motorcycle-related casualty reductions; it considers three casualty classes: slight, serious with no disability and serious with disability. The research produced statistically significant evidence suggesting that the older population is less likely to support investments to reduce casualties. However, the reverse is true for households with higher income and more children. Finally the Willingness to Pay method was shown to be a suitable technique to be used in developing countries to measure the value of motorcycle casualties.

Key words: Motorcycle Safety Valuation, Willingness-to-Pay, Stated-Preference Surveys, Discrete Choice Models

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"He Who taught (the use of) the pen".

"Taught man that which he knew not".

(The Noble Qur-an, Al Alaq: 4-5)

This work is dedicated to:

My Dad, Mom and Son for their spirit from heaven.

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List of Abbreviations

CM	Choice Modelling
CV	Contingent Valuation
DC	Discrete Choice
GBP	Great Britain Pound
GO	Gross Output
IDR	Indonesian Rupiah
ML	Maximum Likelihood
RP	Revealed Preference
SP	Stated Preference
TRL	Transport Research Laboratory
WTP	Willingness to Pay

Chapter 1: INTRODUCTION

1.1 Background

The number of motorcycles has increased rapidly over the past two decades in developing cities in Asia including Surabaya and Jakarta (Indonesia), Kuala Lumpur (Malaysia) and Bangkok (Thailand) (Dimitriou and Banjo, 1990; Mackay et al, 1996; Dissanayake and Morikawa, 2000). Over the period from 1998 to 2004 motorcycle numbers increased from 4.6 million to 6.5 million in the Philippines. In Indonesia, between 2001 and 2004, motorcycle numbers increased from 1 million to 3 million, while in Malaysia the numbers increased from 0.8 million to 1.8 million between 1998 and 2003. Dissanayake and Morikawa, 2000, and Widyastuti and Mulley, 2005, suggest that the increase in motorcycle usage might be related to a lack of convenient public transport as well as the reasonable price of motorcycles.

On the other hand, researchers, including Mannering and Grodsky, 1995, and Vasconcellos, 1996, have identified that motorcycling is an at risk mode of transport due to the complex task of operation, small size and lack of protection for riders. Moreover, as a motorcycle stands on two wheels, this makes it harder for motorcyclists to keep their balance, resulting in a high risk of falling off. In addition, many studies have recognised that a significant number of road accidents resulting in injuries are because of riding motorcycles on public roads (Dimitriou and Banjo, 1990; Mackay et al., 1996; Langley et al., 1997; Reeder et al., 1997). Therefore, as the number of motorcycles rises, the authorities' should pay more attention to the problem of casualties as it is likely that the number of accidents, especially to motorcycle riders, will increase.

In Surabaya (Indonesia), it was found that the chances of motorcycle-related serious and slight casualties occurring were higher than car-related casualties by eight and ten times respectively (Widyastuti and Bird, 2004). These ratios could be even higher if they had been more accurately reported. Unless there is already a policeman at the scene, many motorcyclists do not make any effort to report accidents to the police, even those with casualties, so as to avoid the complicated administration procedures of the police. An informal interview with several students in the Civil Engineering Institut Teknologi Sepuluh Nopember Surabaya who are motorcyclists showed that 99% of them had experienced a motorcycle accident;

moreover almost 100% of those who had experienced a minor accident did not report the details of any casualties if there was no complaint from the victim and the person responsible for the collision, and there was no policeman at the scene.

The potential for motorcycle accidents will increase with the increase of motorcycle numbers (Umar et al, 1995). More motorcycle accidents mean more potential casualties, which not only have an impact on family circumstances, but also the general economy which experiences a loss of productivity from those casualties due to their absence from work. Little attention has been paid to investigating what financial burden motorcyclists have to face when involved in road accidents.

1.2 The Need for Estimating the Casualty Cost in Developing Countries

There are two main purposes for estimating the casualty and accident costs in developing countries. Firstly, to value the total annual national loss, which is based on the loss of productivity resulting from each accident; this can then be estimated at a national level. This number will be useful in evaluating the economic benefits of investing in national road safety programmes. Secondly, an estimation of individual casualty and accident costs can be used for the purpose of economic appraisal and cost benefit analysis. Economic assessments of potential road safety measures can be used to predict the economic benefits of implementing the measures, based upon predicted unit accident cost savings. Economic assessments can also be used as an evaluator of benefits when a scheme has been implemented; such an assessment would be based on actual recorded casualty cost savings as part of the monitoring of a scheme’s success. The resulting figure would reveal how much a particular safety improvement is worth to the affected group in relation to other ways of spending their limited resources. The need to value motorcyclists’ casualty is also increasingly important as the number of motorcycles is dramatically increasing in Indonesia specifically and more generally in other developing countries, while only a few attempts have been made to place a value on motorcyclist casualty as a result of an accident. If this study is successful in quantifying the monetary value for the impact of injury on a motorcycle casualty, the result may prove beneficial for the formulation of future road safety policies or supporting decisions concerning motorcycle safety investment in Indonesia

As stated earlier, Widyastuti and Bird, 2004, produced evidence to suggest that the probability of a motorcyclist being injured in an accident is higher than that for car users. This means that the impact on motorcyclists is more severe than for car users when involved in an accident. This reasoning is taken forward in this study to assess the impact of a motorcycle casualty. Since some impacts, including the pain and suffering experienced due to the casualty, are not market goods, a monetary unit will be used as the unit measurement. All the impact of the accident, including direct cost, productivity cost and pain and suffering, is well known as a casualty cost that arises from an accident.

In the past, different methods, including the[1] Gross Output, the Net Output, the Court Award and Willingness to Pay, have been used to analyse accident costs (Transport Research Laboratory (TRL), 1995; Ross Silcock and Transport Research Laboratory (TRL), 2003). The two methods commonly used in accident valuation include the Gross Output method and the Willingness to Pay (WTP) method (Jacobs et al., 2000). Hills and Jones-Lee (1981) noted that the Gross Output method is relevant when considering the wealth of a country because it aims to establish the economic cost to a country caused by the loss of production time due to casualties. Hills and Jones-Lee (1981) argued that the alternative WTP method is more appropriate when considering social welfare objectives. Equally, the WTP method may raise concerns about people’s awareness of reducing their accident risk. The previous Gross Output method was calculated only as the sum of direct cost and the loss of productivity, but more recently, pain, grief and suffering or human cost have also been taken into account (Transport Research Laboratory (TRL), 1995; Ross Silcock and Transport Research Laboratory (TRL), 2003). In contrast, the WTP method is defined as the sum of direct costs, the net loss of productivity and the casualties’ preferences on risk reduction (Jones-Lee, 1977; Widyastuti et al., 2007; Dissanayake et al., 2008). All costs, the pain, grief and suffering and the WTP values are very individual, subjective and intangible. The pain, grief and suffering, or human cost, in the Gross Output method is determined by adding a fixed percentage

[1] The Gross Output, Court Award and Willingness to pay are some of the accident valuation methods that will be discussed in Chapter 2.

to the direct cost and loss of productivity. In the WTP approach, the WTP value is estimated based on people's preferences or willingness to pay a particular amount of money in order to reduce the risk of an accident.

Previous studies in developing countries, including Indonesia, considered the fixed percentage of the Gross Output produced by the Transport Research Laboratory (TRL) in the UK, which was based on the UK experience. However, there are significant differences between the cost impacts on victims of road casualties in *developed* countries such as the UK, when compared with *developing* countries such as Indonesia. For example, the welfare system in the UK ensures that the medical/hospital costs of road traffic casualties for all UK residents are covered by the National Health Service, which is fully funded by the UK Government through public taxes. Furthermore, the social security system in the UK provides a certain degree of protection against loss of household income for the families of the casualties. Also, compensation may be obtained through insurance and legal proceedings; therefore the direct cost of accidents in the UK is met to some extent by the government or insurance companies. In contrast, developing countries, including Indonesia, do not have welfare systems provided by their governments and the casualties, or their families, must bear these costs themselves (Mohan, 2002). This means that the impact on each casualty can vary widely because an individual's ability to recover depends upon the household's wealth. Therefore, the fixed percentage for expressing the subjective cost, which is used in the Gross Output method for *developed* and *developing* countries, should be differentiated.

Jacobs et al. (2000) reported on the methods used to measure accident cost, stating that of the 20 countries considered, all the *developed* countries, including the UK, had adopted the WTP approach, whilst most of the *developing* countries, including Indonesia, had applied the Gross Output (or Human Capital) approach. Before 1988, the UK government used the Gross Output method for costing accidents. The WTP method was first used in the UK in 1988 and has continued to be used since. The reason for this move was that a study carried out by Jones-Lee et al. (1985) found that the human cost, which is very individual and subjective, should reflect individual interests and preferences which in turn relates to the individual characteristics of the impact on the casualty. In response to this study, the UK government subsequently introduced the WTP method as a way to measure accident or casualty cost.

Road safety valuations carried out in Indonesia that have used the Gross Output method include: Transport Research Laboratory (1993); SweRoad/ Binamarga (1995); Yefrizon and Malkamah (2004); and Sari and Sutomo (2004). Recently, accident cost reports were published by the Asian Development Bank (ADB), and those reports also used the Gross Output method for the estimates. All of the above reports referred to the Transport Research Laboratory (1993) for the fixed percentage to calculate the human cost component. So, it is clear that Indonesia does not have its own method to calculate human costs based on the country's individual experience. This situation also arises in several other developing countries.

Several studies in Indonesia including SweRoad/Binamarga (1995) did attempt to convert the value of casualty cost based on the Gross output method into the WTP method. However, the conversion method was not explained clearly. Nevertheless, the study did find that the accident cost in the WTP method is greater than that derived using the Gross Output Method.

Similarly, with the other costs of casualty resulting from an accident, the cost of a motorcycle casualty comprises three components: direct, indirect and intangible costs. Direct costs are those that have to be borne directly to cover any expenses as a consequence of the casualty incident. These include medical costs, cost for vehicle repairs and administrative costs. The indirect cost is the cost which is borne "indirectly". In this study, the indirect cost consists of the loss of productivity by the casualty as a result of the accident. The intangible cost is the human cost, including pain, grief and suffering valued either by adding a fixed percentage of the total of direct and indirect cost in the Gross Output method or by estimating it by considering the preferences expressed by individuals for reducing the risk of an accident in the WTP method. Measuring the human cost in Indonesia is not easy, since most Indonesians believe that being an accident casualty is a form of "destiny" or an "Act of God".

Research by Reeder et al. (1997) and Langley et al. (1997) provides evidence that most motorcycle casualties are young economically productive people, and some are also family bread-winners. In a serious accident, the casualties may become bankrupt because of the cost of hospital treatment. Furthermore, Ghee et al. (1997) found that in *developing* countries, including Indonesia, hospital costs due to a road casualty incident can be as much as the average monthly income. It is widely acknowledged that, for some people in *developing* countries, the monthly income is spent wholly on sustaining daily life with nothing left for savings. The problems are difficult to imagine when a wage earner has an accident requiring hospital treatment and their salary must be used for the treatment. The problems could be even worse for large families. These circumstances mean the human suffering as well as the casualty cost should be different, depending on the age, earning potential and also the number of children within the family of the casualty.

In recent studies, the discrete choice modelling method has been discussed as a useful technique to model impacts of an event on individual or household characteristics and their preferences (Widyastuti et al., 2007; Dissanayake et al., 2008). This study uses the discrete choice modelling approach that was pioneered by Ben-Akiva and Lerman (1985).

Given the success, over more than two decades, of the use of the WTP method in the UK and several *developed* countries, this research has conducted a comprehensive study in Indonesia to estimate the value of motorcycle casualties using the WTP method and comparing the results with the Gross Output method. In this study, the discrete choice modelling methods are applied to estimate the WTP value, considering binary and multinomial choice options. The data collected through a questionnaire survey is analysed to investigate the relationship between individual characteristics and their willingness to pay for reducing the risk of an accident.- -

Although the literature identifies three classes of casualties: slight, serious and fatal, this thesis only estimates the values of slight and serious motorcycle casualties. The reason for this is that these two casualty types represent the most common types of accident for motorcyclists. Moreover, the respondents in this study are motorcyclists who have experienced road casualties; therefore, for this reason, fatal casualties are irrelevant to this study.

1.3 Research Scope

In this research, the subjective costs have been valued using the WTP method which is considered from the perspective of a reduction in the probability of a particular severity of accident occurrence being prevented by the individual by taking a specific action. The argument is that this methodology gives a better indication of how individuals value safety, rather than react to how much an accident might have cost them. Whilst the WTP method has recently (reference) been introduced in *developing* countries, it has not been applied in Indonesia.

The Contingent Valuation (CV) and the Choice Modelling (CM) methods have been considered to gather the willingness to pay of the respondents. CV has been used in previous studies, including Jones-Lee et al. (1995) and Fauzi et al. (2004). This study had also applied the CV method in the pilot survey; however it was found that the results were inconsistent; therefore, the study adopted the CM instead, because it was anticipated that given pre-determined choices, the respondents would find it easier to decide. Moreover, the CM method enables information and preferences to be dealt with in one question which could help in guiding the respondents in their choice. The empirical analysis was conducted using the data from the city of Surabaya in Indonesia, the capital of East Java Province. The accident casualties in Surabaya, in the year 2002, were 3,692, more than 15% of Indonesia's casualties, and the highest ranking city (Asian Development Bank (ADB), 2009 a).

Considering the reasons above, the research questions of this study have been set up as:

1. Is the Willingness to Pay method applicable to the valuation of motorcycle *severe* and *slight* accidents in a *developing* country, using Indonesia as a case study?
2. Can the discrete choice model be used in the Willingness to Pay method?
3. Is there any relationship between the perceived subjective costs and individual characteristics of the casualty, including age, income and number of children?
4. Is the conversion value of WTP and Gross Output, derived from previous studies in Indonesia, in line with this study in which Surabaya was the study location?

To answer the research questions stated above, this PhD thesis aims to carry out an in-depth investigation into the valuation of road casualties.

1.4 The Aim and the Objectives of the Study

The aim of this research is to establish the value of motorcycle casualties in *developing* countries with due attention to slight and serious casualties, by considering both the Gross Output and the WTP methods and comparing the results to investigate the similarities and differences of these methods. To accomplish the aim, the specific objectives of the research were established as follows:

1 Investigate the suitability of the WTP method in valuing casualty cost in developing countries and analyse the possibility of the discrete choice model being used in the Willingness to Pay method.

2 Critically analyse the relative contribution of socio demographic information; for example, age, gender, income, job status, houshold size and WTP value.

3 Conduct a sensitivity analysis to investigate the changes on the WTP value due to the changes to the socio demographic variables that may be found to be significant in the developed method in objective 3.

4 Conduct an in-depth analysis to explore statistically significant similarities and differences of the casualty costs derived from the Gross Output method and WTP method in this study, as well as other existing studies in *developing* countries in general and Indonesia in particular.

1.5 Research Benefit and Contributions

The expected benefits and contributions of this research are as follows:

1 Provide the possibility of a discrete choice model to be applied on casualty cost analysis, by using the WTP method by considering the social demographic from Surabaya-Indonesia

2 Provide a new figure of casualty cost, using the Gross Output and WTP methods, based on Indonesia as developing country case.

1.6 The Structure of the Thesis

The structure of the thesis is organised into eight chapters, beginning with a glossary of acronyms and abbreviations.

Chapter 1 provides the background to the research, as well as presenting the aim and listing the objectives.

Chapter 2 and Chapter 3 present a review of previous relevant studies. Chapter 2 presents a review relating to valuing an accident/casualty, whilst Chapter 3 presents a methodology for valuing casualty cost using the Gross Output and Willingness to Pay methods. Both methods are used in the valuing of casualty cost.

Chapter 4 describes the case study location in Surabaya, Indonesia. This chapter presents modes of transport that are commonly used in Surabaya, Indonesia, with more detail on motorcycles, whilst the methodology for data collection and analysis used in this study is described in the Chapter 5.

Chapter 6 describes the Stated Preference survey which is used to obtain the willingness to pay of the respondents. This chapter also describes the design of the questionnaire. Chapter 7 analyses the WTP value using the discrete choice model. The models are developed from two types of binary and one multinomial logit for each class of severity. The value of motorcyclist casualty, including direct, indirect and intangible cost, is described in Chapter 8.

Chapter 9 presents the conclusions of the study and makes recommendations for further research, as well as considering the limitations of this research.

Chapter 2: ACCIDENT COST AND CASUALTY COST APPROACH

2.1 Introduction

This chapter reviews the literature on different approaches to accident and casualty cost. Whilst the topic of this thesis is motorcycle accidents, many of the previous studies are concerned with the valuation of the impact of a road accident in general, irrespective of the mode or modes of transport involved. One of the reasons for this is that most studies in this context have been carried out in developed countries such as the UK. The motorcycle mode is rarely used as a main mode of transportation in developed countries and, as a consequence, no specific studies concerning motorcycle accident costs have been carried out in developed countries. However, the literature, which is mainly based on a mixture of modes of transport, remains relevant from an approach point of view.

The literature reviewed is presented in the form of six subsections, namely: Accident versus Casualty Cost; Early Approaches to Valuing an Accident Cost; Different Methodologies for Valuing Accident Costs; and Direct and Indirect costs.

2.2 Accident versus Casualty Cost

This section discusses the difference between the outcome of an accident as an event and an accident as a casualty. When considering an accident as an event, some elements such as a number of casualties or fatalities are taken into account. In contrast, when considering an accident as a casualty, it may be considered as part of the overall impact of the accident.

When there is an accident, irrespective of the mode of transport, the outcome could be one of two kinds: either there is a casualty, to whom one of a number of severity classes is assigned, or there is no casualty at all. The potential outcomes of an accident involving casualties are a slight injury, a serious injury or a fatality to the vehicle driver or passengers. An accident with no casualties is classified as “damage only”.

Historically, the notion of accident cost was introduced to measure "how bad" the accident had been because attention had been focussed on the accident itself, rather than on its constituent casualties. However, some elements of accident cost are derived from the casualty cost, therefore ideally the casualty cost should be established before the accident cost is calculated.

The following subsections discuss in more detail the differences between the accident and the casualty costs.

2.2.1 Classes of Accident and Casualty

The previous section presented the notion that the impact of accidents could be casualty or damage only. The accidents and casualties are categorised into three levels, namely fatal, serious and slight, but the descriptions of each of the categories of accident and casualty found in the literature vary.

A number of studies, including Dawson (1967), Ross Silcock and Transport Research Laboratory (TRL) (2003), distinguish the classes of accident as follows:

- A fatal accident is an accident where at least one person dies.
- A serious accident is an accident where there is no death casualty, but at least one person experiences a serious injury.
- A slight accident is an accident where there is neither a death casualty nor a serious injury, but at least one person experiences a minor injury.

Table 2.1 presents findings from two studies, Dawson (1971) and the Asian Development Bank (2009b), which give details of the number of casualties involved in the three different accident classes, and one study, Highway Economic Note 1 (1999), which presents casualty details for only fatal accidents. It is evident that in a single accident there could be more than one casualty and more than one class of casualty severity involved and clear that the number of fatal accidents has increased along with the increasing years (Table 2.1). For example, in 1971 in the UK there are 1.09 fatalities, 0.43 serious and 0.35 slight casualties involved in one fatal accident. Moreover, in 1971, there are 1.09 fatalities involved in a fatal accident and this figure increases slightly to 1.1 fatalities in 1999, while in Thailand there are 1.16 fatalities in 2009.

Table 2. 1 Average Number of Casualties per Accident

Number of Casualties Involved	Class of Accident								
	UK (Dawson,1971)			UK (Highway Economic Note 1, 1999)			Asian Development Bank. (ADB), 2009b		
	Fatal	Serious	Slight	Fatal	Serious	Slight	Fatal	Serious	Slight
Fatal	1.09			1.1			1.16		
Serious	0.43	1.18		0.42	-		0.48	1.25	
Slight	0.35	0.33	1.23	0.51	-	-	0.43	0.41	1.72

Sources: Dawson (1971), Highway Economic Note 1 (1999) and Asian Development Bank (ADB) (2009b)

The costs of each class of accident can be determined by the number of casualties at each accident class multiplied by the costs of casualty in that severity class. This means the costs of casualty should be determined separately from the valuing the accident costs. In previous research, there is no doubt that the casualty costs calculation is necessary when valuing the overall accident costs. However, although accident classifications have been classified in the same way in most studies, the classifications of casualty are often diverse. The classification of casualty of several studies is described as follows:

Dawson (1967) distinguished the three casualty categories as follows:

- A fatal casualty is a casualty who is dead at the scene or during the following 30 days as a result of an accident (Vienna Convention, 1968).
- A seriously injured casualty is a casualty who had to stay in hospital as an in-patient for at least one day either immediately or at later date.
- A slightly injured casualty suffers a sprain or bruise, but does not need to stay in hospital.

Ross Silcock and Transport Research Laboratory (TRL) (2003) classified the casualty categories in the following way:

- A fatal casualty is a person who is dead within 30 days (Vienna Convention, 1968).
- A serious casualty is defined as either a person who is detained in hospital as an in-patient, or if any one of the following injuries is sustained, whether or not detained in hospital: fractures, concussion, internal injuries, crushing, severe

cuts and lacerations, or severe general shock requiring medical treatment. In the UK, this category includes deaths occurring after a period of 30 days elapsed time following the accident.

- A slight casualty is a person who received an injury with a minor character such as a cut, sprain or bruise.

The study carried out by the Asian Development Bank (ADB) (2009c) to value accident costs in Singapore, defines the casualty categories as follows:

- A fatal casualty is a person who died from injuries as a result of a traffic accident within 30 days of that accident.
- A serious casualty is a person who suffered injury such as fractures or concussion and/or internal lesions, crushed body parts or organs, severe cuts, or severe general shock requiring medical treatment or hospitalisation that prevents the person from performing ordinary tasks for at least 7 days.
- A slight casualty is a person who requires subsequent medical treatment entailing hospitalization and medical treatment for less than 3 days.

Another study carried out by the Asian Development Bank (2009d) to value accident costs in Cambodia classified casualty categories as follows:

- A fatal casualty is a person who died within 30 days of an accident
- A serious casualty is a person who received hospital treatment for 45 days and 5 days of treatment at home
- A slight casualty is a person who did not receive hospital treatment and recovered after two to five days of being treated at home

The Asian Development Bank (ADB) (2009a), in evaluating accident costs in Indonesia, classified casualty severity according to the 14th Indonesian Decree (1990) as follows:

- Fatal casualty means that a person died from injuries sustained in a transport-related accident within 30 days of that accident.
- Seriously injured means that a person was admitted to hospital as a result of injuries from a transport-related accident and received treatment for 30 days or more.

- Slightly injured means that a person is admitted to a hospital because of injuries resulting from a transport-related accident and receives treatment for less than 30 days.

It can be seen from the above review that all the studies have similar definitions for fatal casualty, as well as for serious and slight. However, the Indonesia Decree has different criteria. This leads to different assumptions when it comes to calculating slight and serious casualties in comparison with other countries. For example, in other countries, hospital cost is not included in the slight casualty case, but in a previous study conducted in Indonesia by Sari and Sutormo (2004), hospital and operation cost are also included in valuing slight casualty. The casualty criterion in the Indonesian Decree is different to that used by the police force regarding accident analysis. In an accident scene analysis carried out by the police force, the criterion for slight casualty is defined as a person who does not receive hospital treatment, which is similar to other countries' slight casualty criteria. On the other hand, the number of days that the casualty spent in hospital does not necessarily represent the actual severity of the injuries. However, determining the loss of productivity, using the number of resultant un-productive days, would be a more effective assessment in order to place a value on the measurement of casualty costs. The loss of productive days can be determined by adding the number of days spent in hospital to the recovery time. Table 2.2 shows the range of number of days lost for the purpose of calculating loss of productivity assumed in four different studies.

Table 2.2 The Loss of Days in order to Calculate Loss of Productivity

Study	Yefrizon and Malkhamah (2004)	Asian Development Bank (ADB) (2009a)	Ross Silcock and Transport Research Laboratory (2003)	Transport Research Laboratory (TRL) (1995)
Country Concerned	Yogyakarta, Indonesia	Indonesia	Bangladesh	Cyprus
Slight casualty (days)	6	30	5	2
Serious casualty (days)	56	60	35	37
Age of pension (year)	65	60	58	66

Sources: Asian Development Bank (ADB) (2009a); Yefrizon and Malkhamah (2004); Ross Silcock and Transport Research Laboratory (TRL) (2003) and Transport Research Laboratory (1995)

Table 2.2 shows that every country has different figures for the loss of productive time with regard to each class of casualty. Although several studies suggest that the type of injuries experienced by slight casualties are those that do not need overnight medical attention in hospital, such as cuts and bruises, nonetheless the un-productive time has to be calculated as shown in Table 2.2. This takes into account any recovery time needed at home. For slight casualty, the loss of productive days has a considerable range from 2 days up to 30 days. The lowest number is derived from Cyprus, at only 2 days, whilst the highest number is in Indonesia where the study was performed by the Asian Development Bank (ADB). However, the other study carried out in Indonesia, by Yefrizon and Malkamah (2004), suggested that the un-productive time for slight casualty was only 6 days. The difference in number may be due to dissimilar assumptions regarding what constitutes slight injury. The study carried out by Yefrizon and Malkamah (2004) assumed that a slight casualty is a person who had not received hospital treatment and recovered after several days of being treated at home, whilst the study by the Asian Development Bank (ADB) assumed that slight casualty represents a person who receives treatment for less than 30 days as a result of a traffic accident. In the case of serious casualty, it can be seen in Table 2.2 that different countries have different assumptions concerning the loss of productivity time, for instance Bangladesh has adopted the notional period of 35 days and Indonesia around 56 to 60 days. The loss of productivity for fatality is determined by the gap between the age of pension and the average age of fatality. The average number of days' stay in hospital for a fatality was identified as 2.4 by Dawson (1967); in contrast, the Transport Research Laboratory (TRL) (1995) considered it to be 4 days.

2.2.2 Casualty and Accident Costs Components

Dawson (1967) and the Transport Research Laboratory (TRL) (1995) identified the medical cost, loss of productivity and subjective costs as the components of casualty costs, whereas damage to vehicle, property costs and administration costs are identified as being accident costs. Another study carried out by Hopkin and O' Reilly (1993) stated that the medical and ambulance, loss of output and human costs (pain, grief and suffering) are a burden on each casualty, while damage to vehicles and property, as well as police and administration costs, have to be distributed evenly across all the casualties in the accident.

Based on researchers' opinions mentioned above, it can be concluded that the casualty cost's elements are the burden suffered by the casualty recovering from all injuries and any impact that occurred after the injury, including loss of productivity and subjective cost. Any other payment that is not related to injury payment, such as vehicle repair and administration, is included in the accident cost's element. The accident cost can also be a burden to the casualties; however, the accident cost will not be a burden that is exclusive to one casualty; it will be distributed evenly between all casualties involved in the accident. So basically, the casualty's elements comprise all casualty elements and accident elements.

2.2.3 Summary of Accident Costs versus Casualty Costs

The result of an accident could be casualty and/or vehicle damage. The studies reviewed show that in a particular accident more than one type of casualty could be involved. It should also be noted that most studies dealt with accident costs rather than casualty costs; however, the accident cost can simply be calculated from the number of casualties involved multiplied by the cost of casualty because accident cost is the total cost incurred by all casualties involved in the accident. Therefore, the casualty cost should be determined before calculating the accident cost. For this reason, this study aims to value casualty costs followed by a subsequent valuation of accident costs. Consequently, the data has been collected from the individual casualties.

Several studies differentiate casualty and accident cost: casualty is the burden of expenses incurred by the casualty such as medical and ambulance cost, while the accident cost is a general cost that is a burden to all of the casualties who were involved in the accident; for example, damage to vehicle and property damage costs. The burden of the costs is distributed between all the casualties involved in the accident, which means that the components of accident cost are also a burden to the casualty. In conclusion, the casualty cost component consists of medical and ambulance costs, damage to vehicles and property, as well as police and administration costs, loss of output and pain, grief and suffering. All these cost components suggest a gathering of information directly from the casualty rather than being based on secondary data assumption. By interviews with respondents who had experienced an accident, it is hoped that it will be possible to collect real direct costs and other burden costs.

In order to avoid confusion, it is necessary to classify the severity of casualty criteria such as slight, serious and fatal casualty. In particular, it is vital to define the number of days spent in hospital for slight and serious casualty. This will have a significant impact on the valuing of the loss of productivity cost.

2.3 Early Approaches to Valuing Accident Cost

This section discusses the historical development of the assessment of accident costs. Historically, accident costs were constituted by the direct and indirect costs of an accident. Later studies led to an understanding of another important element to be included in the analysis: intangible costs. This type of cost introduced the notion of the individual's experience in an accident and also covered 'pain, grief and suffering'.

2.3.1 Approaches to Valuing Accident Cost

Dawson (1967) quoted an earlier work by Jones (1938), which was the first published estimate of accident costs in the UK. The study estimated the total costs of an accident as being made up of three elements: "compensation for personal injury, repair for damage of property and administration costs" which were found to be in the following proportions, 82%, 8% and 10% respectively. There is no explanation as to whether the personal injury compensation took the casualty's loss of productivity into account or not. The costs of damage to property were obtained from a sample of vehicle accidents, which was taken from army vehicle accident records. Those accidents were considered as being typical of road accidents.

Dawson (1967) reported that the UK Government Actuary (1938) published the costs of accident subdivided into four components of costs: the "present value of loss of output or reduction in earnings, hospital and doctors' costs, repair for vehicle and property costs and legal and administrative expenses". The categories in the UK

Government Actuary (1938) study differ from those in Jones (1938) as the Actuaries report used the loss of output and hospital and doctors' components instead of the compensation for personal injury. Also, the average earnings of casualties were differentiated between men and women. In addition, different approaches to valuing property damage costs were adopted. The UK Government Actuary (1938) valued the costs relating to the injury of casualty, while Jones (1938) did not. This idea was adopted because damage to property costs could be higher in accidents where there was an injury to a person rather than if there was damage to property, but no injury to a person. In addition, the UK Government Actuary separated out the administrative expenses and legal costs, whereas Jones (1938) did not take legal costs into account at all.

Reynolds (1956) categorised components of accident costs into "value of loss of output, costs of medical treatment, costs of damage to property and administration costs". In that study, he identified three new elements in the valuation of the loss of output over previous studies (UK Government, 1938). These were as follows:

- the Gross National Product is used to provide a valuation of the actual loss of output for the individual who sustained the injury rather than using average earnings;
- the housewife's services are taken into account in the valuation by using the average female wage rate;
- and the Net Loss of Output is calculated as a value for the whole of the expected life of the fatality.

Dawson (1967) carried out an empirical study of the costs of road accidents based on secondary data from the UK. The cost components considered included "value of loss of output, costs for medical treatment, costs of damage to vehicles and other property, costs for administration and others, and subjective cost". In the Dawson study, the accident costs were classified into three separate groups of casualties, including fatal, serious injury and slight injury. Furthermore, the different classes of costs were also grouped according to the location of accident, namely urban or rural areas.

Several developed countries, including the UK and New Zealand, traditionally valued accident costs by taking into account their effect upon gross (or net) output. Under the Gross (Net) Output approach, the costs of a fatality constitute the sum of vehicle damage, medical costs and other real resource costs which are then added to the discounted present value of the individual's future output (or income) as a result of the victim's premature death and pain, grief and suffering costs (Hammerton et al., 1982). Similarly, O'Reilly (1992) reported that between 1968 and 1987 the Department of Transport (DOT) in the UK valued road accident casualty costs using the Gross Output method in which the costs of medical treatment and the pain, grief and suffering would be allocated to specific casualties, while the costs of damage to vehicles, property, police and administration costs for insurance were distributed among all casualties involved in the accident. Fundamentally, the Gross Output method is made up of the value of loss of output, the costs of medical treatment, the costs of damage to vehicles and other property, the administrative and other costs and a "Subjective Cost". The Transport Research Laboratory (TRL) (1995) and Mohan (2002) stated that the costs should include an element covering pain, grief and suffering which is assumed to be a quality of life cost; on the other hand, Dawson (1967) and Ross Silcock and the Transport Research Laboratory (2003) were more concerned with what was referred to as subjective costs associated with the "human cost" arising from casualties. However, since 1988, the DOT has valued the costs by considering how much people would be willing to pay to reduce the risk of being killed in a road accident and that value is added to the net output and medical costs. This presumably resulted from considering a conventional costs benefit analysis, which expresses the aggregate amount for an individual's willingness to pay. Therefore, the casualties would play a role in the assessment of the potential accident costs and increasing the benefit from road transport safety improvement. For these reasons, Hammerton et al., (1982) mentioned that several economists, including Jones-Lee, suggested that the UK government should value a transport safety improvement by valuing the accident costs based on individual willingness to pay.

Even though the UK government and several developed countries, including the USA and Sweden, have valued accident costs using the Willingness to Pay (WTP) approach since 1988, other studies such as the Transport Research Laboratory (TRL) (1995) and Ghee et al. (1997) have stated that the costs associated with road accidents, in developing countries, would be more appropriately analysed using the

Human Capital approach (Gross Output) method. This was because they thought the Willingness to Pay questionnaire was too complicated for developing countries' citizens, especially in view of the lower percentage of literacy in the populations of developing countries compared with developed countries.

Downing (1997) recorded that there had been two earlier studies in Indonesia, carried out by the Transport Research Laboratory (TRL) (1993) and SweRoad/Binamarga (1995). Both studies were based on the Gross Output method. More recently, the Asian Development Bank (ADB) (2009 a, b, c, d, f, g, h, i, j) released an accident costing report for several countries in the Asean region including Cambodia, Indonesia, Thailand, Singapore and Vietnam. The reports for all these countries valued accident costs using the Gross Output method. The costs reported included property damage, administration costs, loss of output, medical costs and human costs, defined in terms of pain, grief and suffering.

2.3.2 Summary of Early Approaches to Valuing Accident Costs

The earliest study of accident costs in the UK (Jones, 1938) looked at only three components, which were not clearly enough defined to establish whether indirect components were covered or not. The next development was the UK Government Actuary Report (1938) in which the indirect cost was recognised. Since the Government Actuary findings began to be reported, accident cost valuations started to take into account both direct and indirect costs components. The direct costs component comprises medical and non-medical cost, whereas indirect costs consist of loss of output. In 1967, Dawson initiated a consideration of the subjective costs in valuing accidents and, more recently, the subjective costs have been extended to include pain, grief and suffering and human costs, as well as the notion of a loss of quality of life. These developments try to capture the subjective costs associated with the impact of an accident on a casualty. All literature after 1967 differs from the early studies by routinely including indirect costs covering loss of output and an amount for pain, grief and suffering (human costs) in addition to the direct costs component. The pain, grief and suffering and human costs in terms of quality of life are strongly individual and could differ between individuals even where there the apparent severity of injury is identical. Hence, several studies, including Dawson (1967), have referred to this cost as the “Subjective Cost” often referred to as the intangible cost. Since then, all accident cost studies have invariably taken direct, indirect and intangible cost into consideration.

2.4 Different Methodologies for Valuing Accident Cost

This section looks in more detail at the different methodologies used for valuing the impact of accidents and includes more recent developments in this area.

Typically, accident costs are broken down into direct, indirect and intangible costs. The direct costs generally consist of the out-of-pocket costs, including the following: medical, vehicle and other property damage and administration costs. Indirect cost has been expressed as the loss of productivity by the casualties; the intangible cost, which is valued by the Gross Output method, covers pain, grief and suffering. Several studies have called this cost the subjective or the human cost, or the loss of quality of life; and when valued by the Willingness to Pay method the intangible costs have been expressed as the preferences of people to reduce risk, the value of statistical life/injury. Even though it may be difficult express exactly in monetary units, some studies including, Jones-Lee et al. (1983), Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (2003) have developed methodologies to determine the financial burden on the casualty as well as the economic impact of the accident.

Evans (2006) stated that in the Gross Output method, which is sometimes also known as the “Human Capital Approach”, the subjective cost which covers pain, grief and suffering, and also the loss of quality of life that occurred is figured with a fixed percentage which is added on top of the total of direct and indirect cost. However, the major objection to the human capital approach is that most people do not value their loss of quality of life primarily for its contribution to cost incurred as a result of an accident, but because it has a natural value to them. Therefore, most economists believe that valuations should be based on the preferences of those who benefit from safety measures and who also pay for them, either directly or through taxation. These preferences are measured by the amounts that people are willing to pay to reduce the risk of death and injury, which is the so-called ‘willingness to pay’

(WTP) approach. Many countries, including the UK, now adopt this approach in their official valuations of road casualties.

From the many studies in the literature, there is a wealth of information on the calculation of accident costs. However, most of the studies refer to Hill and Jones-Lee (1981). Although the methods could be used for calculating the costs of varying severities of accident, including slight, serious and fatal, most descriptions refer to fatal casualties. Presumably this is because a fatality is seen as the worst case.

Hills and Jones-Lee (1981) summarised six methods for the valuation of the accident cost, these being: Net Output, Gross Output, Life Insurance, Court Awards, Implicit Public Sector and Willingness to Pay. These methods have also been cited by many studies including Jones-Lee et al. (1985); Transport Research Laboratory (TRL) (1993); Downing (1997); Jacob (2000); Ross Silcock and Transport Research Laboratory (2003); the Costs of Road Accident Reports on several Asean Countries which were published by Asian Development Bank (2009 a, b, c, d,f,g,h,i,j), Widyastuti et al. (2007) and Dissanayake et al. (2008). Additionally, Widyastuti et al. and Dissanayake et al. (2008) stated that the direct and indirect costs elements are considered by all methods. Among all the methods, the gross output method and the WTP methods are widely used in road safety valuation (Jones-Lee et al. (1983); Downing (1997); Jacobs, (2000); Ross Silcock and Transport Research Laboratory (TRL), (2003).

The six methods could be categorised into three groups reflecting their similarity, these being: output based, revealed method and willingness to pay approach.

2.4.1 Output Based Measures

The Net Output and the Gross Output are methods of valuing the effect of accidents on society and they have emphasised the loss of output of those involved in the accident and those who are affected by it. Dissanayake et al. (2008) wrote that the total value of the Net Output method consists of the direct costs and the net output loss. Whilst, the value of casualty, which is analysed using the Gross Output (human capital) method, is calculated by adding together the direct cost, gross output loss, and human costs. 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.

As the Gross Output method was developed in the context of valuing the life lost in a fatal accident, it is clear that the discounted value could be adjusted to reflect the loss of output in an accident in which the victim is injured, as opposed to killed. In the Gross Output approach, the loss of future output of a person killed is determined as the average of wage rates (Gross Output) of lost output both in the year the death occurred and then for future years up until the average retirement age. Costs in the future years during which the casualty might have lived, have to be discounted back to give present day values. Then the value of human life or fatal casualty is taken as the sum of direct costs and a discounted value of a victim's future output to give present day values of the fatality (Hills and Jones-Lee, 1981). On the other hand the costs of serious and slight casualties are calculated as a sum of direct costs and the loss of output/productivity during the period when the casualties are receiving treatment. Recently, in the Gross Output Method, a value has been added as an allowance for 'pain, grief and suffering' or the subjective costs of the accident. Typically these are added as a fixed percentage of the output measured on top of direct and loss of productivity to give the total intangible cost, this being the basis of the 'human cost' valuation approach; the fixed percentages that are usually used are 8% for slight, 100% for serious casualty and 38% for fatal (The Traffic Engineering Division, Institute of Road Engineering Bandung Indonesia, 1990; Transport Research Laboratory (TRL), 1995; Ghee et al., 1997 and Ross Silcock and Transport Research Laboratory (TRL), 2003). In the net output approach, the gross output figure is determined by subtracting the discounted value of the victim's future consumption.

Recently the Gross Output method, which was published by Dawson (1976) in the UK, has become one of the two most commonly used methods for valuing accident/casualty cost studies, especially in developing countries. However, since this method has been initiated in developed countries, there have been a lot of assumptions based on the experience of developed countries rather than developing countries themselves.

2.4.2 Revealed Methods

A second broad group of accident costs measurement can be identified as being revealed from an individual’s behaviour. These include looking at the amounts which individuals are prepared to insure against loss of life or limb (the Life Insurance approach), the amounts awarded by the Courts for compensation to survivors (the Court Awards method) or surviving dependants (in the case of a fatality) and the last method, which is determined by deriving values implicitly from investment programmes that influence safety (the ‘implicit public sector valuation’ approach). With ideal information, the figures revealed by any of these valuations would cover both the costs to society and the subjective costs of casualties. In reality, the different methods will capture the full cost, which includes direct, indirect and intangible costs, in different ways. On the one hand it might be expected that the Life Insurance approach would be the most accurate since the individual should be identifying the full costs of the accident when choosing the level of insurance. In this approach, the loss of output costs of life or the subjective costs are defined as the amount for which individuals are willing to insure their own lives or limbs (Hills and Jones-Lee, 1981). However, the amount of insurance cover provided might be considered as an estimate by the insured person of the value of their life to their dependants, which means the amount may not reflect the value to the insured of their own life (Transport Research Laboratory (TRL), 1995). The Court Awards method again should reflect the full costs, but the system in many countries is imperfect in aligning compensation payments with costs. In developing countries where insurance for individuals, vehicles and third-party insurance is uncommon, the life insurance and court award approaches would not be appropriate because there is a lack of data. The implicit public sector valuation approach again offers a valuation of the full indirect costs imposed by an accident, but in practice investment in different sectors has given rise to widely differing values for safety improvements or safety requirements (Hill and Jones-Lee, 1981). All of these methods are rarely used in the developing countries.

2.4.3 Willingness to Pay Methods

Essentially, the reason for a decision made in the public sector regarding any allocation of limited resources should reflect the preferences and wishes of those individual citizens who will be affected by the decision (Jones-Lee, 1989). Furthermore, Evans (2006) argued that most economists believe that the value of casualty should be counted based on the preferences of people who obtained a benefit from safety measures and who also pay for them, either directly or through taxation. These preferences could be measured by the amounts that people are willing to pay to reduce the risk of an injury. This measurement procedure is internationally recognised and is known as the Willingness to Pay (WTP) approach.

Goodchild et al., (2002) stated that the Willingness to Pay approach could be used to place a value on the total of accident cost; many studies including Persson (2001) and Jones-Lee et al. (1995) have suggested the application of the Willingness to Pay method for valuing the human costs of casualty, costs which relate to an individual and are subjective. Furthermore, if the decision-makers are genuinely concerned about the quality of life and social well being of their citizens, then they should use the Willingness to Pay method (Ross Silcock and Transport Research Laboratory (TRL), 2003) to obtain a measure of the costs people are willing to pay to reduce risk or prevent accidents. Similarly, Alfaro et al. (1994) asserted that fundamentally this approach is based on the possibility that each individual has a chance of being involved as a casualty in road accident. Michell and Carson (1993) and Alpizar et al. (2001) suggested that in the case where a *good* has not yet existed, but the impact is real, then it can be categorised as *a non-market good*. On the other hand, Bateman et al. (2002) referred to the situation as being similar to the intangible costs which include pain, grief and suffering, as a result of an accident which could be classified as a *non-market good* because the impact is real, but the costs incurred are not real. Moreover, Bateman et al. (2002) and Islam (2002) believe that Willingness to Pay is a suitable method to use to analyse a *non-market good*.

Currently this method is most used in developed countries such as the UK, USA, and Sweden. This is due to the belief that this method better reflects people's preferences with regard to reducing their risk.

2.4.4 The Role of Objectives in the Choice of Valuation Method

Hills and Jones Lee (1981) identified four objectives, which should be considered when deciding upon the appropriate accident valuation method to be used. These are as follows:

- National Output objective such as maximisation of Gross National Product (GNP) or National Income.
- Other Macroeconomic objectives such as specific allowance for the effect of accidents on employment and inflation.
- Social Welfare objective such as the minimisation of all types of accidents in the interests of the well being of the community as a whole.
- Mixed objective, in which the objective of the study is a combination of all or a combination of the above objectives in various forms.

However, essentially the reasons for costing road accident are most likely to be either the maximisation of national output or the pursuit of social welfare objectives (Hills and Jones-Lee, 1981; Jacobs, 2000), which means the only accident costing or valuation methods that appear to be directly relevant to the two objectives are:

a) The “Gross Output" method, which is suited to the objective of maximising the wealth of a country or

b) The "Willingness to Pay" (WTP) method, which is used to maximise the pursuit of the social welfare.

Since the WTP method is appropriate to the pursuit of social welfare, this method is appropriate for use in conventional cost-benefit analyses in order to determine the most efficient way of allocating scarce financial resources (Jacobs et al., 2000).

2.4.5 Summary of Different Methodologies for Valuing Accident Cost

Several approaches to accident costs have been published by Hill and Jones-Lee (1981); however concerning the objective of accident cost in studies, which is maximising the wealth of a country or maximising the pursuit of social welfare, there are only two methods that are commonly used, the Gross Output and WTP methods.

Some developed countries, including the UK, use the WTP method to value the cost, whereas developing countries, including Indonesia, employ the Gross Output method. -

2.5 Direct and Indirect Costs

Many studies have considered the overall costs of an accident as being made up of three categories, namely, direct, indirect and intangible costs, regardless of which valuation method has been applied.

This section considers in more detail direct and indirect cost components and this is useful as it defines the relevant costs as well as the potential sources for data collection for both categories.

Many studies, including Dawson (1967) and Transport Research Laboratory (TRL) (1995), preferred to value accident costs rather than casualty costs. This is understandable because the idea of valuing the costs is for its use in costs benefit analyses for road safety investment appraisals where the valuation of accident costs are of particular concern. However, because some components of the accident costs are calculated on a casualty basis, the casualty costs should be determined before and then incorporated into the overall accident costs.

2.5.1 Direct and Indirect Cost Components

The direct costs mainly consist of the out-of-pocket costs, including injury treatment, property damage, workplace disruption and insurance claims processing (Goodchild et al., 2002). Whilst the indirect costs of an accident represent the loss of productivity which is caused by a temporary absence from work caused by the casualty (Putignano and Pennisi, 1999).

In general, direct costs fall into two categories: medical costs and non-medical costs.

The medical costs are the direct costs incurred by the casualty for medical treatment. This could be because the casualty has to stay in hospital as an in-patient or attend as an out-patient and has to receive medical treatment such as bandages, pain killers, blood transfusions and operations, and any other expenditure on goods and services, such as nurses, General Practitioners and ambulances, relating to the medical care of patients as a result of an accident (Goodchild et al., 2002). Direct non-medical cost is the direct costs that might be incurred in addition to the medical costs. Dawson (1967), Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (2003) indicated that non-medical costs comprise of the costs of vehicle and other property damage, administration of insurance and police or court proceedings that might arise as a result of the accident. Unlike the medical cost, which is categorised as a casualty cost, Dawson (1967), Alfaro et al. (1994), Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (2003) regard the vehicle and property damage and administration costs as falling into the category of direct non-medical costs and depend on the type of accident that occurred.

2.5.2 Valuation Method of the Direct Cost

As a starting point, the accepted methodology for valuation is to divide the total costs arising from an accident (whether evaluated at the accident or casualty level) into direct costs (such as identifiable medical costs following the accident), and indirect costs (such as loss of output for the country following an accident where the casualty is unable to work for a certain period or where the casualty dies).

Measurement issues for the direct costs relate to the way in which the costs can be estimated either from a ‘top down’ approach, where aggregate data is investigated to provide relevant estimates, or a ‘bottom up’ approach where individual values are sought from victims of accidents.

Identifying and valuing indirect costs is more problematic because the costs are not incurred directly. The costs are valued for the loss of productivity as a result of absence from work or job; for example, the length of stay in hospital or time required for home care.

Direct cost: Goodchild et al. (2002) stated that there are two possible methods for assessing direct costs. These are: the “prevalence method” (top down) and the “incident method” (bottom up). According to the study, in the top down approach the total direct expenditures are known; then, to calculate the amount of direct costs in each category, the total expenditures are distributed according to the frequency of occurrence of accident in the sub-categories, expressed as a percentage of the total number of accidents. While in the bottom up (incident) approach, the direct costs of each sub-category are known, and those direct costs are aggregated to obtain an estimate of the total direct costs.

Loss of productivity: Unlike direct costs, which are easily recognised, the indirect costs are more difficult to identify. The indirect costs express the loss of earnings to the casualty (loss of output or productivity cost) as a result of the accident. Moreover, in many developing countries, citizens are not in paid employment; this group includes housewives and children for whom no real income can be considered.

Dawson (1967), Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (2003) calculated the loss of output according to the casualty classes (slight, serious and fatal). In all cases the total loss of output is determined as the wage per day multiplied by the number of unproductive days that resulted from an accident. Dawson (1967) calculated the total loss of productivity for a fatal casualty, using several different average measures such as average wage, average consumption and average duration of working life. Dawson (1967) also calculated the loss of productivity of males as being the number of working fatalities multiplied by the expected life and then multiplied by the average annual earnings. In both cases, costs are discounted to the present values.

Valuing accident costs using the net output method, the consumption forgone is taken from the loss of output or productivity. The consumption forgone from a fatal accident is estimated as the number of fatal casualties multiplied by the average expected life and then multiplied by the average annual consumption; these are then summed up and discounted. The net loss for female casualties, who are not in paid employment, e.g. housewives, will be negative as there is no loss of productivity. However, he took into account the intangible (subjective) cost which renders the costs positive. Later, Dawson (1971) suggested changing this calculation of loss of output from the net output method to the gross output method. The main difference between these methods is that in the net output approach the loss of productivity is offset by consumption forgone, whereas the gross output method does not deduct consumption forgone. Based on the assumption above, it could be concluded that the value of severity (serious and slight) when valued using the Gross Output and Net Output is the same. This is due to no future loss of productivity of the expected life that should be taken into account. However, in looking at safety awareness, Dawson (1971) suggests the use of the gross output rather than the net output method, since a safety awareness programme has to also consider the fatal casualty and the Gross Output method is able to calculate the future loss of productivity of the expected life.

In the case of fatality, Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (2003) suggested that the lost time should be measured from the average age at the time of the accident and this should be subtracted from the average age of retirement before multiplying by the wage of the casualty. The loss of productivity costs in each of future years until retirement must be discounted to give present day values (Dawson, 1967; Transport Research Laboratory (TRL), 1995 and Ross Silcock and Transport Research Laboratory (TRL), 2003). Dawson (1967) used 6% as the discount rate; while the Transport Research Laboratory (TRL) (1993) used 9% for the project in Cyprus. Those studies estimated the productive time loss as the number of days that the casualty could not work. In the case of a slight casualty, the time lost may be relatively small, as the casualty may not stay in hospital. The loss of productivity of a slight casualty could be caused by appointments as an out-patient to receive treatment for a minor injury; alternatively, the time lost by simply being at home recovering could also be included. In the case of serious casualty, Transport Research Laboratory (TRL) (1995) and Ross Silcock and Transport Research Laboratory (2003) suggest that the loss of productive time for a serious casualty is the number of days which the injured person spends in hospital together with the time spent at home recovering from the accident. In addition, Ross Silcock and Transport Research Laboratory (2003) proposed that the time involved in looking for employment if the casualty loses their job as result of the accident should also be taken into account.

2.5.3 The Identification of Relevant Costs

In general, the cost components of the direct cost comprise of medical and non-medical costs. The medical cost may be incurred for in-patient or out-patient hospital treatment plus any expenditure on goods and services relating to the medical care of patients arising from an accident, including psychotherapy or rehabilitation and also including the ambulance costs of the accident and emergency services (Alfaro et al., 1994 and BTRE, 2003). The non-medical costs are the direct costs incurred in addition to the medical costs such as police administration and vehicle repair costs. The indirect costs are the loss of productivity whilst the intangible costs express the pain, grief and suffering in the Gross Output method or the preferences of people with regard to risk reduction in the WTP approach.

Dawson (1967) and Transport Research Laboratory (TRL) (1993**)** stated that the accident costs components that need to be collected to calculate medical costs include the length of stay in hospital, the average costs per day, the average number of out-patient visits, the average costs per out-patient visit, the average costs incurred by general practitioners and the costs incurred by the ambulance service. While Alfaro et al. (1994) described the medical costs as being the sum of first aid and ambulance costs, accident and emergency services costs, in-patient and out-patient treatment, non-hospital treatment and the cost of aids and appliances. Tervonen (1999) and Islam (2002) reported that the medical costs only comprise of four components: ambulance, first aid, hospital treatment and home treatment. Quite similarly to Alfaro et al. (1994), Silcock, and Transport Research Laboratory (TRL) (2003) estimated that, in general, the medical costs are an aggregation of at the scene of accident care, first aid and transportation to hospital, in-hospital stay and out-patient treatment, including medicine and prosthetics if any. All of these cost elements are needed to value the medical costs of the serious casualties, whereas for slight injury in which the casualty has not spent time in hospital, the only data needed is the out-patient costs (Ross Silcock and Transport Research Laboratory (TRL), 2003). Dawson (1967) and Transport Research Laboratory (TRL) (1993) suggested that out-patient and general practitioners (GP) costs can be ignored for a fatal casualty, as it is assumed that the severity of the casualty causing death before return home meant no out-patient costs were incurred. However, the assumption to ignore the General Practitioner costs is not well supported because there is no reason why only General Practitioner costs should be ignored when other costs, such as a few days in-hospital for the fatal casualty, are taken into account when assessing casualty costs for a fatality.

Table 2.3 gives a summary of the components of medical costs that have been considered in several studies when valuing accident costs. It can be seen that differences exist in the selection of elements used to estimate direct costs and this reflects the differences in the structure and valuing of the direct costs. However, all of the studies consider ambulance/transportation to the hospital and in-hospital costs as elements of medical costs. Furthermore, most of the studies also include outpatient costs. Regarding the funeral cost, Dawson (1967) ignored funeral costs because he thought this cost would be incurred by everyone at some time; however, later on Dawson (1971) changed his views and took the funeral costs into account. Ross Silcock and Transport Research Laboratory (2003) suggested that discounted funeral costs could be taken into account when assessing fatal casualty.

Table 2.3 Components of Medical Costs

Costs component of Medical costs	Literature source				
	Dawson (1967)	Alfaro et al. (1994)	Transport Research Laboratory (TRL) (1993)	Tervonen (1999)	Ross Silcock and Transport Research Laboratory (2003)
At scene costs					✓
First aid		✓		✓	✓
Ambulance/transportation to	✓	✓	✓	✓	✓
Out-patient costs	✓	✓	✓		✓
In-patient hospital costs	✓	✓	✓	✓	✓
Home/non hospital treatment		✓		✓	
Medicine					✓
Aids and appliances		✓			
GP costs	✓		✓		
Prosthetics					✓
Funeral costs					✓

Sources: Dawson (1967); Alfaro et al. (1994); Transport Research Laboratory (TRL) (1993); Tervonen (1999) and Ross Silcock and Transport Research Laboratory (TRL) (2003)

Tervonen (1999) gives more details for direct and indirect costs components: medical costs (ambulance and first aid, in-patient and out-patient), administrative costs (police, fire department and court), material costs (vehicles and infrastructure repair), loss of productivity and consumption (loss of productivity/capacity) of an individual, lost consumption of an individual, loss of household and voluntary work, replacement costs of an employed person and income transfers due to incapacity to work, costs of rehabilitation (assistive equipment and physical rehabilitation). Medical costs, administration costs and material costs are categorised as direct cost, whilst the loss of productivity and consumption and the costs of physical rehabilitation are categorised as indirect costs.

Elvik (2000) and Islam (2002) agreed that the direct costs consist of the out-of-pocket costs, including injury treatment, property damage, workplace disruption and insurance claims processing, whilst the indirect costs of accidents include the losses in social value attributable to premature death, permanent impairment, or temporary absence from work caused by the accident. Moreover, Elvik (2000) stated that direct and indirect costs of accidents are referred to as the market values of the accident costs.

2.5.4 The Identification of Data Sources

The literature provides evidence on how and from where the data needed to value accidents should be collected. Dawson (1967), Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (2003) collected the medical costs data from hospitals, while the non-medical data was collected from several companies such as insurance companies, garages and large fleet operators; however, Dawson (1967) suggested the need to be careful in using such sources of data since many vehicles may not have had insurance. Unlike vehicle damage and medical costs, data that can be readily collected directly from insurance companies, garages, hospitals or General Practitioners, other administration costs are difficult to obtain. Since the administration costs are typically a small proportion of direct costs, Transport Research Laboratory (TRL) (1993) suggested using a fixed proportion of the total direct costs as a reasonable estimate. Transport Research Laboratory (TRL) (1993) suggested using 0.2% for a fatal accident and 14% for a slight accident. Table 2.5 shows the summary of data sources for medical and vehicle repair costs used by different studies.

Table 2.4 Source Data for Element of Medical and Vehicle Repair Cost

Costs Category	Literature Source	Source of Data Proposed
Medical Costs	Dawson (1967)	Hospital costing return (1963) which was published by the Ministry of Health and hospitals.
	Transport Research Laboratory (TRL) (1993)	Hospital and published government reports.
	Ross Silcock and Transport Research Laboratory (TRL) (2003)	Hospital expenditure estimates, insurance payment claims by casualties. Hospital casualty surveys or household surveys were also used.
Vehicle repair	Dawson (1967)	The British Insurance Association (B.I.A.) and Lloyds.
	Transport Research Laboratory (TRL) (1993)	Insurance companies (or alternatively, garages specialising in repair work), An alternative approach would have been to use the relative costs of spare parts and labour in the UK.
	Ross Silcock and Transport Research Laboratory (TRL) (2003)	Insurance companies, garages and large fleet operators.

Sources: Dawson (1967); Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (TRL) (2003)

From Table 2.4 above, it can be seen that most of these studies collected data and information from secondary data, with the exception of Ross Silcock and Transport Research Laboratory (TRL) (2003) who suggested collecting the data based on the hospital casualty or household surveys. It is almost certainly advantageous to obtain primary data despite the time and cost implications, as a direct interview with the casualty is likely to yield a better understanding of the burden borne by the casualty in terms of the financial impact of their road accident.

Regarding the loss of productivity cost, the data required is the duration of absence of the casualty from work and the wage of the casualty. When costing accidents in the UK, Dawson (1967) used data from the National Insurance statistics to find the duration of slight casualties' absence from work, but when this was not available he arbitrarily assumed that the loss of working time was one day. Transport Research Laboratory (TRL) (1995) estimated the loss of productive time for a slight casualty as being two days; this was based on a study undertaken in Cyprus. Transport Research Laboratory (TRL) (1993) identified that the necessary information for slight and serious casualties' loss of employed time could be collected from a hospital record or alternatively from the insurance or an employee's records. A later study by Ross Silcock and Transport Research Laboratory (TRL) (2003) suggested collecting the lost output time from a household casualty survey, although it was recognised that such a survey was both costly and time consuming.

Alternatively, to obtain the wage data, Dawson (1967) estimated the loss of productivity for a serious injury based on the data from the “Digest of Statistics Analysing Certificates of Incapacity” published by the Ministry of Pensions and National Insurance. He suggested that when the casualty was a housewife who had no income, the average female wage rate could be used. Alternatively a carer’s income could be used to value the housewife’s contribution. To estimate the income of a casualty, Ross Silcock and Transport Research Laboratory (2003) gave guidelines for the collection of wage data from national income statistics, travel time surveys, and hospital or household casualty surveys. Transport Research Laboratory (TRL) (1993) noted that in a developing country, the government might not publish statistics of wage rates and therefore the estimation needs to be based on the aggregate annual incomes per capita. Moreover, Ross Silcock and Transport Research Laboratory (TRL) (2003) suggested that the easiest way to collect the data might be from the national income statistics, but this may tend to over-estimate the income of motorcyclists since these casualties are likely to be from the lower income group and the average of all the population certainly includes car owners. However, the study argued that the best way to collect loss of time data for serious casualty data is from a household survey.

2.5.5 An Example of Valuing Direct and Indirect Cost

As Table 2.3 shows, there are many different ways to calculate the medical costs (MC), depending on the elements considered and the class of casualty. For example, Dawson (1967) determined serious casualty medical costs using secondary data, which was collected from several hospitals. Dawson used seventeen days as the duration of stay in hospital for serious casualties, a figure that was obtained from several sample hospitals. He assumed that the daily hospital costs were Great Britain Pounds (GBP) 5 (£5) and the total costs of a serious casualty’s hospital treatment was obtained by multiplying the costs of hospital treatment per day by the duration of stay in the hospital, giving the result of GBP 85 (£85). The average of General Practitioner costs for serious casualties was collected from various sources including the Hillingdon Hospital, the Birmingham Accident Hospital and the Chief Financial Officers of England and Wales. The GP medical costs for serious casualties were taken from the average of those three sources, which was GBP 5 (£5). The last component of the medical data was the ambulance costs which were obtained from the Ministry of Health and it was stated to be as much as GBP 1.25 one pound and twenty five pence) for a serious casualty. The average medical costs for a serious casualty were GBP 91.25 ninety one pounds and twenty five pence), an aggregate of the three components: ambulance, in-patient hospital and GP costs. This proposal can be formulated as follows:

$$MCss_i = AmCss_i + (IHDss_i * HCss_i) + GPss_i \qquad 2.1$$

Where:

$MCss_i$	=	Medical costs of a serious injury casualty $_i$
$AmCss_i$	=	Ambulance costs of a serious injury casualty $_i$
$IHDss_i$	=	Duration of stay, in days, in hospital for a serious injury casualty $_i$
$HCss_i$	=	Daily hospital costs for a serious injury casualty $_i$
$GPss_i$	=	General practitioner (GP) costs for a serious injury casualty $_i$

For slight injury casualties, Dawson (1967) assumed the medical costs for slight casualties as the average of general practitioner and ambulance costs, which was GBP 5.75 (five pounds and seventy five pence). The equation is as follow:

$$MCs_i = AmCs_i + GPs_i \qquad 2.2$$

Where:

MCs_i	=	Medical costs of a slight casualty
$AmCs_i$	=	Ambulance cost
GPs_i	=	General practitioner cost

To calculate the amount of accident costs of a serious accident, Dawson (1967) used data from the Ministry of Transport statistics to obtain the coefficient of overall costs of accidents that assumes each serious accident consists of 1.17 serious casualties and 0.33 slight casualties. The medical costs, then, of a serious accident will be GBP 109 (one hundred and nine pounds) a rounded number from 1.77 * GBP 91.25 + 0.33 * GBP5.75 = GBP108.66.

The formula of the medical costs therefore becomes:

$$MCsa = \{(a_{ss} * MC_{ss}) + (b_s * MC_s)\} \qquad 2.3$$

Where:

$MCsa$	=	Medical costs of serious accident
MC_{ss}	=	Medical costs of a serious casualty
MC_{s}	=	Medical costs of a slight casualty
a_{ss}	=	Coefficient of the serious casualties involved
b_{s}	=	Coefficient of the slight casualties involved

In general, non-medical costs' constituents include administration and material costs. These costs are categorised as accident costs, where the calculation is not based on the casualty, but based on the accident type.

Ross Silcock and Transport Research Laboratory (2003) used four steps when computing vehicle damage costs which were categorised as material costs. First, determine the average number of every type of vehicle involved in the various classes of accident; for example, there were 0.59 motorcars involved in every serious accident. The second step was to analyse the average number of vehicles damaged in every accident. For example, if 80% of motorcars involved in serious accidents are damaged, this means 0.59 * 0.8=0.47 motorcars were damaged in serious accidents. Following the above example, suppose the average costs of motorcar damage in a serious accident was GBP 17,585, then the last step in finding the average vehicle damage costs per class of accident would be to multiply the average vehicle damage in the class of accident by the average costs of the type of vehicle in the class of accident; in this case the vehicle damage costs of a serious accident = 0.47 * GBP 17,585 = GBP 8,264.

Regarding the administration cost, Ross Silcock and Transport Research Laboratory (2003) stated that the costs are very low in comparison to the damage costs. Furthermore, Ross Silcock and Transport Research Laboratory (2003) suggested not paying too much attention to the administration costs. They suggested using percentages of the direct costs: 2.8% for insurance administration and 0.6% for police costs.

Most research, including Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (2003), suggests the following formulae for the calculation of the loss of productivity costs of the casualty:

- Lost productivity of a serious casualty = {(number of in-patient days and days visiting medical facilities + number of days at home recovering from injuries +

number of days searching for new employment) * (average daily wages of casualty)}.

- Lost productivity of a slight casualty = {(number of days spent visiting medical facilities + number of days at home recovering from injuries + number of days searching for new employment) * (average daily wages of casualty)}.

When calculating the loss of output costs, Hopkin and O'Reilly (1993) suggested that there are some variations in the approaches used, in particular when using gross or net values and whether these incorporated a discount rate. Moreover, they also agreed that if the WTP was used for valuing casualty costs then the net output method should be used for costing the loss of productivity. On the other hand, Alfaro et al. (1994) suggested that when valuing accident costs using the WTP method for non-fatal accidents, the gross output method was to be used for valuing loss of productivity costs because the non-fatal casualties did not stop consuming.

2.5.6 Summary of the Direct and Indirect Costs

From the studies mentioned above, it can be concluded that the direct costs were evaluated using a top down method, based on total expenditure and then distributed to sub-categories based on a percentage share of the total. The percentage share is normally derived from an assumption or an average of several sources of data. The assumption consists of several steps, with some of the steps being interlinked; hence, were there to be a mistake in one step, it would have an impact on the other steps and, therefore, the process may create inaccurate results.

From these previous studies, it can be concluded that most of the cost estimates are based on secondary data; however, in order to reduce the possibility of incorrect valuation of the direct costs, this study has used the bottom up method, which is based on a casualty questionnaire. This method is consistent with that of Ross Silcock and Transport Research Laboratory (2003), studies which suggested obtaining the data based on hospital casualty costs or a household survey, but warned that those methods have time and cost consequences; moreover, a direct interview of a casualty is likely to give a better understanding of the financial burden on the casualty as a result of their road accident.

2.6 Intangible Costs (Subjective Costs and WTP Value)

Beside the direct and indirect costs discussed above, there are intangible costs, which should be taken into account. In the Gross Output method, the intangible cost is compensation for the loss of quality of life and the pain, grief and suffering of the victims and their relatives as a consequence of being involved in accidents (Putignano and Pennisi, (1999), Tervonen (1999), Elvik (2000) and Islam (2002)). Previous studies referred to the loss of quality of life as the subjective cost (Dawson, 1967). In the WTP approach, the intangible costs express the preferences of people to reduce risks. Moreover Elvik (2000) mentions that the components of accident costs related to valuation of loss of quality of life are referred to as the non-market values of accident costs. Therefore, Islam (2002) argued that, since the subjective costs are categorised as non-market values, the WTP method should be used to value the human costs.

Jones-Lee (1990) argued that the main objection to valuing accident costs using gross output is that most people value safety because of their "aversion prospect" rather than to protect their output or income, therefore the WTP method is suggested as the appropriate method for valuing subjective costs (human cost). Furthermore, Hopkin and O'Reilly (1993) agreed that WTP results should be used for quantifying the subjective costs. However, Transport Research Laboratory (TRL) (1993), Ghee et al. (1997) and Ross Silcock and Transport Research Laboratory (2003) argued that the developing countries might have difficulty in using the WTP method because it requires the completion of complex questionnaires in which questions ask about risk prevention and payment. Many studies, including Transport Research Laboratory (TRL) (1993); Ghee et al. (1997) and Ross Silcock and Transport Research Laboratory (2003), suggested that the gross output approach should be used in developing countries. Alfaro et al. (1994) argued that, in a practical valuing system, the gross output method was most appropriate for valuing the human cost.

2.6.1 Subjective Cost in the Gross Output Method

Dawson (1967) was the first to propose how to deal with the subjective cost and used a fixed amount of GBP 5,000 (five thousand pounds) per casualty.

Previously this amount had been used to make the total of the housewife casualty costs positive under the net output method. However, when the gross output method was used, Dawson (1971) retained this element as part of the total accident costs as a non-resource cost.

Several studies, including Silcock, and Transport Research Laboratory (TRL) (2003), agreed that the human cost should be taken into account when costing accident cost by using gross output and suggested adding a fixed percentage onto medical, non-medical and loss of output for each casualty to derive the human costs of fatal, serious, and slight casualties. The fixed percentages suggested by Transport Research Laboratory (TRL) (1995) and Ross Silcock and Transport Research Laboratory (2003) are 38% for a fatality, 100% for a serious casualty and 8% for a slight casualty. However, it was acknowledged that the percentages for serious and slight injuries used by Transport Research Laboratory (TRL) (1995) were based on the UK experience in 1992 (Hopkin and O'Reilly, 1993). Nevertheless, it remains possible to use a different percentage which would more accurately reflect the situation in the country in which the study was to be carried out. A major study in Indonesia, which was concerned with the costs of road accidents, was carried out by Transport Research Laboratory (TRL) in 1993, the results of which have been followed up by SweRoad/Bina Marga (1995), Yefrizon and Malkamah (2004) and Sari and Sutomo (2004). They valued accident costs in Indonesia using the gross output method, taking into account the pain, grief and suffering as an expression of the subjective costs. In those studies, the calculation of the subjective costs (pain, grief and suffering) followed the same pattern as the Transport Research Laboratory (TRL) (1995) study and were assumed to be 8% for slight casualty, 38% for fatal and 100 % for serious casualty.

Similarly, Jordan, Hashem et al. (1998) determined the costs of accidents using the human capital approach. In this study, secondary data from hospitals was used to estimate medical costs, and the loss of productivity was estimated by multiplying the off-work period in days by the average gross earning per day. To take into account the pain, grief and suffering costs, the study suggested the use of 27.5% of the total hospitalisation and medical treatment costs for seriously injured casualties and 20% of those costs for slight injured costs. Hopkin and O'Reilly (1993) identified that countries such as Belgium, France and Austria use court awards as a proxy for the costs of pain, grief and suffering, while Spain determines the subjective costs for pain, grief and suffering as being as much as 50% of the value of the loss of output.

2.6.2 Willingness to Pay Values

Jones-Lee (1989) mentioned that value of individual life is reflect in what people would be willing to pay (or sacrifice) to obtain benefits or to avoid costs. Therefore, it can be assumed that the individual would be willing to sacrifice some of his present income or wealth in order to reduce the probability of death or injury. The WTP approach assumes that individuals are willing to pay for improvements in their own and others' safety even if the improvements are small. Eckhoudt and Hammit (2001) also suggested that the individual's willingness to pay to reduce the risk can be estimated by multiplying the change in the probability of death or injury by an estimate of the individual's marginal rate of substitution between wealth and mortality risk (injury risk). The marginal rate of substitution is described as the value of a statistical life (VSL) or value of prevention of the injury.

Hammit (2000), explained the Value of Statistical Life (VSL) as the individual's preference for small changes in risk (w) and income (p), with the formula given below:

$$VSL = \frac{dw}{dp} = \frac{u_a(w) - u_d(w)}{(1-p)u_a^{'}(w) + pu_d^{'}(w)} \qquad 2.5$$

Where:

u_a = Utility of risk *a*

u_d = Utility of risk *d*

Dionne and Lanoie (2002) agree that dw/dp is the marginal amount of WTP that corresponds to the value of statistical life.

Regarding the value of statistical life, many researchers identified the relationship between the value and the socio-economic and demographic characteristics of the individual. For example, Hammit (2000) recognised that the value of a statistical life depends on wealth and might also depend on health. He concluded that the trade off between income and reducing risk could vary over the life cycle (age). Johansson (2002) agreed with this and suggested that the value of statistical life (VSL) could vary with age. Moreover, Jones-Lee (1989) and Horowitz and Connell (2003), found that there is a correlation between income or wealth as well as age and safety prevention. These circumstances apparently are analogous with the discrete choice principle, which was developed by Ben-Akiva and Lerman (1985). They stated that the discrete variables could be described from the behaviour of an individual person, household, or firm. They also stated that the development of disaggregate models, based on discrete choice analysis, was a major innovation in modelling analysis. Similarly, Bierlaire (1997) declared that the results of several decisions of each individual in the population would raise a choice or demand. Furthermore, Tamin (2000) confirmed that the probability of individuals choosing a given option is a function of their socioeconomic characteristics and the relative attractiveness of the option.

In addition, regarding accidents where motorcyclists are involved, Lin et al. (2003) and Rutter and Quine, (1996) stated that young and male motorcyclists have a stronger tendency towards risky behaviour. Similarly, Mannering and Grodsky (1995) mentioned that young and male motorcyclists perceived themselves to be at a greater risk of accidents. On the other hand, Chang and Yeh (2006) recognised that there is a correlation between accident risk, age and gender. They acknowledged that young and female riders compared with their older and male motorcyclists, were more likely to be involved in an accident. But interestingly, female motorcyclists apparently had a higher accident risk than their male counterparts at the same age. Furthermore, Rutter and Quine (1996) identified that a young motorcyclist tends to exhibit high risk behaviour, such as a willingness to break the law and to violate the rules of safe riding, which plays a much greater role in accident involvement than inexperience.

Recognising that the impact of a motorcycle incident is not always similar between one motorcyclist casualty and another, especially in respect to the subjective costs, this study will value a motorcyclist casualty by taking relevant characteristics, such as age and income, into account and will use the stated preference method modelled by discrete choice in order to analyse the WTP value. Furthermore, since there are few WTP studies concerning non-fatal casualties, this study will only consider valuing the motorcyclist's serious and slight injury casualty costs.

Moreover, since this study uses primary data, and primary data from the fatally injured motorcyclist would be very difficult to obtain because grieving families tend to be reluctant to give information, fatal casualties are not considered.

2.6.3 Summary of the Intangible Costs

There is much evidence to suggest that intangible costs, which express the human costs in the gross output method, and the WTP value in the WTP approach, are difficult to express in monetary units.

Many developing countries, including Indonesia, have assessed casualty and accident costs using the Gross Output method which values the intangible costs using the fixed percentage of the sum of the direct and indirect costs. In contrast, many developed countries, including the UK, have assessed these costs using the WTP method. Considering that intangible cost expresses pain, grief and suffering or the wish to protect one from fatal injury, makes intangible cost very subjective and individual, where the amount varies for each individual depending on subjectivity and circumstances. With the Gross Output method, the subjective cost is determined with a fixed value for each individuals, making it impersonal. However, with WTP value, the amount can be set individually according to the parameter, such as gender, age or income. Therefore, the WTP method should be applied in developing countries, including Indonesia, to give a picture of the intangible cost of a developing country citizen in general as well as the casualty cost.

2.7 Accident Cost Studies in Indonesia

Several accident and casualty costs studies have been carried out in Indonesia (Transport Research Laboratory (TRL), 1993; SweRoad/Binamarga, 1995; Yefrizon and Malkamah, 2004 and Sari and Sutomo, 2004). In addition, the Asian Development Bank published the Accident Costing Report of Indonesia, using the work of Sari and Sutomo (2004) as their evidence. All of these studies, in valuing casualty costs, used the gross output method where the subjective costs were estimated using fixed percentages as suggested by the Transport Research Laboratory (TRL) (1995) and the loss of output costs were valued using the gross output method. As seen in Table 2.5, these studies presented costs expressed in the Indonesian Rupiah (IDR) and found different results (Table 2.5).

Table 2.5 Casualty Costs Using Gross Output Method (IDR)

Severity Classes	Transport Research Laboratory (TRL) (1993)	SweRoad/ Binamarga (1995)	Sari and Sutomo (2004)	Yefrizon and Malkhamah (2004)
Fatal	191,876,073.55	156,207,768.20	327,338,385.00	159,167,000.00
Serious	13,773,269.66	13,493,029.81	21,365,939.00	25,850,000.00
Slight	2,553,296.41	2,594,813.43	6,082,118.00	787,000.00

Sources: (Transport Research Laboratory (TRL) (1993); SweRoad/Binamarga (1995); Sari and Sutomo, 2004 and Yefrizon and Malkhamah, 2004).

Recently, Dissanayake et al. (2008) valued casualty cost using the WTP approach based on a questionnaire derived from the contingent valuation method. As shown in Table 2.6 the values were found to be higher than those based on the Gross Output method, shown in Table 2.5.

Table 2.6 Casualty Costs Using WTP Method (IDR)

Severity Classes	Dissanayake et al. (2008)
Fatal	351,878,479
Serious	32,158,058
Slight	10,152,138

Source: Dissanayake et al. (2008)

Downing (1997) noted that Transport Research Laboratory (TRL) (1993) and SweRoad/Binamarga (1995) had different results when they converted the willingness to pay to the gross output value, but no explanation was presented as to why these differences occurred. Table 2.7 shows the different results of both studies.

Table 2.7 Willingness to Pay Conversion's Number Suggested

Severities	Transport Research Laboratory (TRL) (1993)	SweRoad/Bina Marga (1995)
Fatal	2.6 x Gross Output with Subjective Cost	2.93 x Gross Output without
Serious	3.25 x Gross Output with Subjective Cost	5.46 x Gross Output without
Slight	3.7 x Gross Output with Subjective Cost	1.11 x Gross Output without

Source: Downing (1997)

From all the studies described in Table 2.5, only the study carried out by Yefrizon and Malkamah (2004) valued accident costs in Indonesia using primary data. The data collected involved road traffic accidents of all vehicle types.

2.8 Discussion of the Accident and Casualty Costs

This chapter has reviewed the literature on valuing accident costs. Despite the many studies offering different methodologies to value accident costs, this review has narrowed the scope for identifying the most suitable methodology for valuing accident costs for motorcyclists in developing countries. However, this review also contributed important understanding of the valuing of motorcyclist accident costs, as follows:

- Building up accident costs from individual casualty costs is better than looking at accident costs per se and gives a list of reasons.
- There are no studies focusing on motorcycle accidents.
- Whilst output measures based on bottom up approach data are likely to be more accurate, these have not been carried out in Indonesia.
- WTP approaches have many theoretical advantages, but have only so far been employed in developed countries and it is necessary to compare this with output based measures.

All of the studies in Indonesia valuing the subjective costs use the fixed percentages which were recommended by the Transport Research Laboratory (TRL) (1995); however, the percentage is based on UK experience and no study has taken into account factors that are based on the Indonesian context.

Both methods have advantages and disadvantages; therefore, this review suggests that both methods should be used and the results compared. Moreover, (Johansson 2002) argued that perceived values should always be greater than the actual costs incurred. Some previous studies that used the gross output method recommended the collection of secondary data. However, in this study primary data will be collected using a questionnaire that will be distributed to the casualties.

As the casualties have to cover their own medical and other costs while they are not earning, the overall impact of a casualty is greater when there are more family dependants and less income. Moreover, age and other socio-economic and demographic data relating to the individual will be analysed in this study.

Previous studies have considered valuing accident cost by considering the economic evaluation for investment. On other hand, in an accident there could be more than one casualty involved and also there could be more than one type of the severity classes; therefore, this study decided to consider valuing casualty cost first. Basically, the method being used to analyse accident cost and casualty cost is the same.

There are several accident cost methods that have been published; however, the Gross Output and WTP methods are the most common approaches that have been employed in the last few decades. Most of the developed countries apply the WTP method while the Gross Output method is commonly used in developing countries. No matter which method is being used, the cost component comprises of direct, indirect and intangible cost. The direct cost comprises of several components, and it was found that differences exist amongst researchers in the selection of these elements. However, all of the studies consider ambulance transportation to the hospital and hospital costs as elements of medical costs and outpatient costs as a component of direct cost. Taking this into consideration, this study will apply the same component of direct cost on valuing the casualty cost, using the Gross Output and WTP methods. For indirect cost, the Gross Output method analysed the indirect cost for fatality on a gross basis, while net basis was employed to analyse the severity. On the other hand, the WTP method was utilised to analyse all types of casualty using net basis. In this study, the types of casualties being analysed are slight and serious, therefore net basis will be used for analysis of the casualty cost both when using the Gross Output and the WTP methods.

Unlike direct and indirect cost, analysing the intangible cost for the Gross Output and WTP methods is very different. The intangible of the Gross Output method, commonly known as Subjective cost of the Human Cost is gained from a fixed percentage on top of the total of direct and indirect cost. The common fixed percentage used in Indonesia is 8% for slight casualty and 100% for serious casualty. However, the fixed percentage being used is based on the UK's experience, which was published by the Transport Research Laboratory (TRL). The fixed percentage should not be taken for granted as it is, bearing in mind that the UK, as a developed country, has a social welfare system in place for its citizens, while Indonesia, as a developing country, has not applied such a system comprehensively. For countries that have a social welfare approach to medical provision, the medical costs are not incurred directly by the casualty. For example, in the UK, when a casualty has medical treatment due to a road accident, the casualty does not pay anything for the medical treatment at the point of need. Many developed countries have similar social welfare conditions to the UK and thus previous studies in developed countries suggested the collection of the medical costs data should be based on hospital expenditure or any secondary data available. Conversely, in developing countries where there is no social welfare medical provision and there is a lack of secondary data, using assumptions and adjustments based on secondary data might be inaccurate. In addition, for some countries where insurance is not a compulsory part of vehicle ownership, the cost of the vehicle damage will fall directly onto the casualty. Meanwhile, the Intangible of the WTP method, commonly known as WTP value, is gained from people's willingness to pay for the probability of reducing risk. Up to the time when this study was conducted, Indonesia had been applying the Gross Output method for valuing accident cost, which means analysing the intangible cost using fixed percentages.

Taking into consideration the circumstances described above, this study has applied the Gross Output and WTP method in order to analyse the motorcyclist casualty cost and compare the results.

Chapter 3: GROSS OUTPUT AND WILLINGNESS TO PAY METHOD FOR VALUING CASUALTY COST

3.1 Introduction

This chapter reviews the literature concerning the Gross Output and Willingness to Pay (WTP) methods in more detail, including a comparison between both methods and the accident cost value in several countries which have valued casualty cost using the Gross Output or the WTP method.

The literature reviewed is presented in four sub sections, namely: A Comparison between the Gross Output and WTP Methods of valuing, the Gross Output Method, WTP Method and Discussion of the Gross Output and WTP Methods for the purpose of Valuing Casualty Cost.

3.2 A Comparison between the Gross Output and WTP Methods of Valuing

Historically, there are many published accident cost methods; however, there are two methods that are most commonly used, the Gross Output and WTP methods. The difference between both methods lies only in their valuing of intangible cost.

3.2.1 Subjective Cost in the Gross Output Method

Evens (2006) stated that the Value of Statistical Life (VSL), which is analysed using the WTP method, consists of WTP value, loss of net output and medical and ambulance costs (direct costs), given as:

$$VSL = WTPvalue + Net\,Output + Direct\,Cost \qquad 3.1$$

While,

$$V(Net\,Output) = V(Gross\,Output) - V(Consumption) \qquad 3.2$$

Similarly, Jones-Lee (2003) suggested that the value per fatality (VPF), which is analysed using the WTP method, is given as:

$$VPF = WTPvalue + NO + MA \qquad 3.3$$

Where:

$$NO = GO - C \tag{3.4}$$

Therefore, the value per fatality is:

$$VPF = WTP + (GO - C) + MA \tag{3.5}$$

Where:

VPF	=	Value per fatality
GO	=	Gross loss of output (Gross loss of productivity)
NO	=	Net loss of output (Net loss of productivity)
WTP	=	Willingness to Pay value
C	=	Future consumption
MA	=	Medical and Ambulance (direct cost)

This definition is comparable with that proposed by Evens (2006). Given that accident types were limited to *slight* and *serious* casualties, the future consumption (C) may be ignored as the consumption can only been considered for a person who died before his/her retirement as a result of the accident. The consumption from a fatal accident assume as the future consumption loss as the result of the premature death. And since $C=0$ for slight and serious casualties, therefore the value per casualty based on the Gross Output method is calculated as:

$$VPC = MA + GO + WTP \tag{3.6}$$

VPC	=	Value per casualty
MA	=	Medical and Ambulance (direct cost)
GO	=	Gross loss of output (Gross loss of productivity)
WTP	=	Willingness to Pay value

While the value of casualty based on the Gross Output method is calculated as:

$$VPC = MA + GO + HC \tag{3.7}$$

Where:

VPC	=	Value per casualty based on the Gross Output method
MA	=	Medical and Ambulance (direct cost)
GO	=	Gross loss of output (Gross loss of productivity)
HC	=	Human cost, including pain, grief and suffering

As explained previously, in general, casualty costs comprise of direct, indirect and intangible costs. Taking into account the formulae in 3.6 and 3.7, the direct cost is represented by medical and ambulance (MA) costs. The Gross Loss of Output consists of the indirect cost, while the intangible cost of the WTP, named as WTP value and human cost (HC), presents the difference of the Gross Output method.

Dissanayake et al. (2008) illustrated the difference between the accident costs methods of Gross Output and WTP, as shown in Figure 3.1

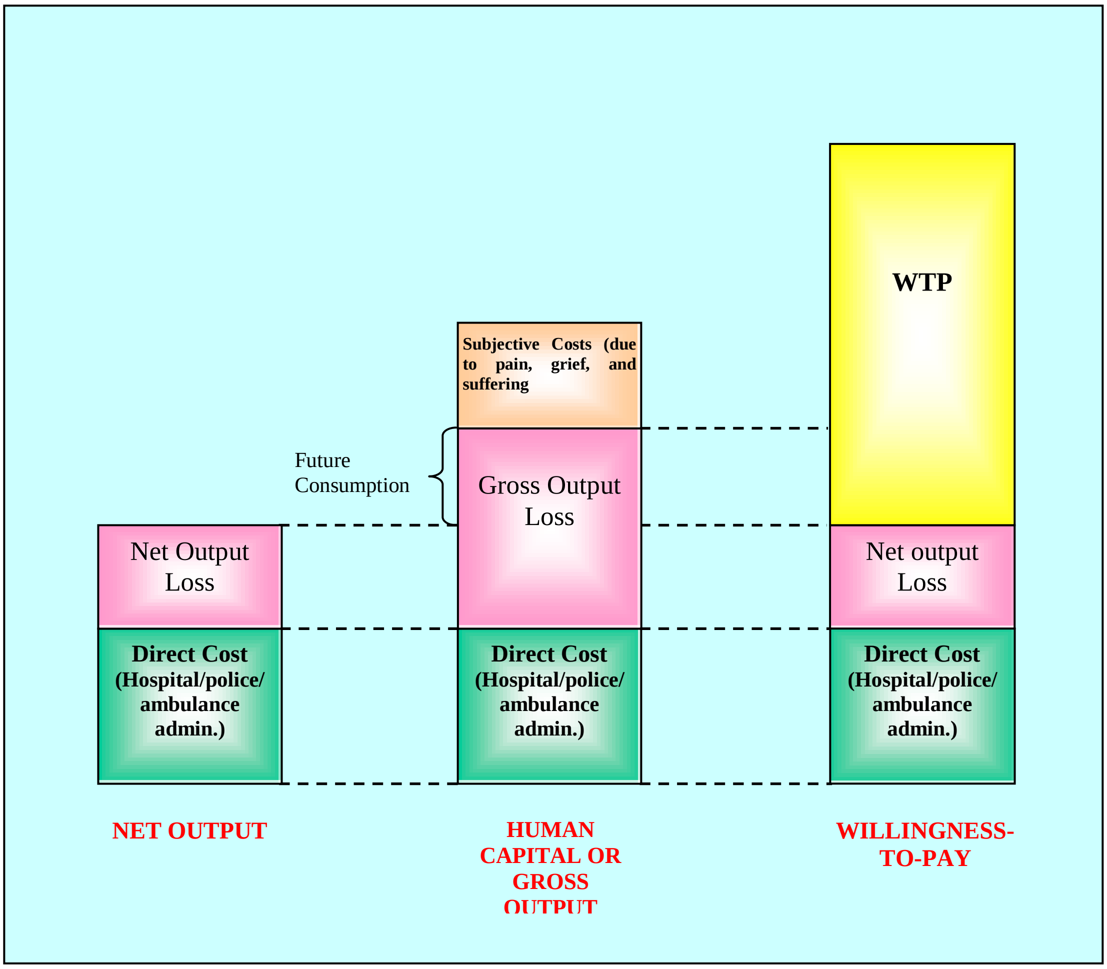

Figure 3. 1 Differences between Costs Calculation Methods
Source: Dissanayake et al. (2008)

Figure 3.1 illustrates that the intangible cost based on the WTP method has a higher value when compared to the Gross Output method. This might be because people preferences as far as safety awareness is concerned are more accurately expressed by employing the WTP method rather than using a fixed percentage.

3.2.2 Summary of the Comparison between the Gross Output and WTP Approaches to Valuing Casualty Cost

It can be seen from the above that the difference between the WTP and Gross Output methods lies in the way they deal with the intangible costs. The Gross Output method values the intangible cost using a fixed percentage, while the WTP method values it using WTP value which is determined by people preferences regarding reducing their risk.

For fatality casualties, the indirect costs (loss of productivity cost) are different in the Gross Output and the WTP methods; however, for slight and serious injury the indirect costs are the same because there is no need to consider future consumption loss.

3.3 The Gross Output Method

This is one of the two methods that are commonly used, especially in developing countries. Initially, the intangible cost, commonly known as subjective or human cost, is irrelevant in the Gross Output method. Dawson (1967) initiated the application by giving a fixed amount for the subjective cost. Subsequently, a fixed percentage on top of the total cost was employed to arrive at the subjective cost. Some studies regarding the amount of the fixed percentage are elaborated upon in the following sub section along with a consideration of the casualty cost value in several countries.

3.3.1 The Subjective Cost in the Gross Output Method

Several studies, including the Transport Research Laboratory (TRL) (1995); Trawen et al. (2001) and Ross Silcock and Transport Research Laboratory (2003) referred to Net or Gross Lost Output as the loss of productivity of the casualty. Recently, there has been a trend for a number of developed countries, who previously used the Gross Output method, to move towards employing the WTP method. Nonetheless, most of the developing countries still apply the Gross Output method. Some research, including Trawen et.al (2001), states that, due to the complicated questionnaire utilized in the WTP method, the developing countries are advised to use the Gross Output method.

A fixed percentage on top of the total direct and indirect cost is used to gain the subjective cost that represents pain, grief and suffering in the Gross Output method. However, this fixed percentage is not necessarily the same in all the countries that have applied this method. The Asian Development Bank (2009a) stated that the percentages used in the UK were increased several times at 100% for serious, 38% for fatal and 10% for slight injury. In Cambodia, the fixed percentages being applied are 28% for fatal, 50% for serious and 8% for slight injury, according to the Asian Development Bank (2009b). On the other hand, Laos used 40% of the total cost for fatal accident, 60% and 10% of the total cost for serious and slight injury respectively. While India and Nepal used 20% of lost output costs. The fixed percentages suggested by the Transport Research Laboratory (1995) and Ross Silcock and Transport Research Laboratory (2003) are 38% for a fatal casualty, 100% for a serious casualty and 8% for a slight casualty.

Alfaro et al. (1994) noted that as far as human costs are concerned, using such fixed percentages would not be relevant in every country because several of them employ insurance payments or court compensation and few countries utilise the WTP method in order to value human costs.

3.3.2 Casualty Costs in Several Countries that Utilise the Gross Output Method

Several countries have applied the Gross Output method, including several Asean countries, such as Singapore, Brunei and Indonesia. Recently, the Asian Development Bank has published an Accident Costing Report which consists of the casualty and accident cost of several Asian Countries. Most of the countries have applied the Gross Output Method and the casualty cost as presented in Table 3.1.

Table 3.1 shows that Brunei has the highest fatality value followed by Singapore, while Laos has the lowest value. For serious and slight injury, Myanmar has the highest value followed by Singapore and again, Laos has the lowest value. One of the deciding factors in determining casualty value is the indirect cost, which is the result of multiplying a casualty’s wage by unproductive time. Since

Singapore's GDP/capita is higher than other Asian countries, it is understandable that Singapore ranks as the second highest, while Laos ranks bottom, nonetheless, Myanmar offers a surprise by coming first with its high value of fatality and casualty costs.

Table 3.1 Casualty Cost Based on the Gross Output Method

Country	Currency	Fatal	Serious	Slight
Brunei Darussalam	US$	1,202,718	52,874	8,020
	GBP	778,880	34,241	5,194
Cambodia	US$	21,906	10,489	1,263
	GBP	14,682	6,793	818
Indonesia	IDR	327,338,385	21,365,939	6,082,118
	GBP	21,198	1,384	394
Laos PDR	US$	7,203	2,120	384
	GBP	4,665	1,373	249
Myanmar	MMK	5,016,909	1,308,498	79,715
	GBP	499,039	130,158	7,929
Philippines	$	2,273,017	353,242	69,423
	GBP	33,415	5,193	1,021
Singapore	S$	1,409,847	127,876	14,168
	GBP	703,662	63,509	7,071
Thailand	Bath	2,870,822	155,278	36,474
	GBP	61,538	3,328	782
Vietnam	D	175,380.00	56,090,000	36,090,000
	GBP	11,358	3,632	2,337

Source: Asian Development Bank (2009 a, b, c, d, e, g, h, i, j)

3.3.3 Summary of the Gross Output Method

Several countries have applied the Gross Output Method in order to value casualty cost; however, the percentages used to determine the subjective cost vary. For slight injury, the percentage used ranged from 8% - 10%, serious casualty ranged from 50% up to 100%, while for fatal casualty the percentages ranged between 28% - 38%.

Since the indirect cost is interpreted by the loss of unproductive time multiplied by the casualty's wage, it follows that a country's casualty cost will also be determined by their GNP/capita and the higher the GNP/capita is, the higher the casualty cost will be.

3.4 The Willingness to Pay Method

Accident cost using Willingness to Pay (WTP) method was initially published by Jones Lee circa1989. As a result of that study, the UK, which originally applied the Gross Output method, initiated the conversion towards using the WTP method.

3.4.1 Survey Method for Gathering Willingness to Pay Value

Unlike the determination of intangible costs in the Gross Output method where it is based solely on direct and indirect costs data, to determine the WTP's value, it is necessary to conduct a survey to gather people's WTP on reducing risk.

Jones-Lee et al. (1985); Evan (2006) and Zhu (2003) stated that there are two methods of collecting data in order to estimate how much an individual would be willing to pay for a reduction in the risk of sustaining an accident, namely, the "Revealed Preferences" and the "Stated Preference" approaches. The study explained that the revealed preference approach tries to identify and observe how people trade-off between income and physical risk, while in the questionnaire method, a sample of people are asked directly how much they would be willing to pay to reduce their own or other people's risk. Jones-Lee et al. (1985), Dionne and Lanoie (2002) and Bateman et al. (2002) distinguished the methods as follows:

- The Revealed Preference (RP) method, where the value obtained is based on market data;
- The Stated Preference (SP) method, where the value obtained is based on querying the respondents who place a value on those ***non-market goods*** or willingness to pay for a small safety risk reduction.

Bateman et al. (2002) stated that the RP technique is recommended when the actual decision of an individual is consistent with the WTP's assumption. The revealed preference approach involves identifying situations where people do actually trade off money against risk, such as when they may buy safety measures or when they may take a more or a less risky job for higher or lower wages; while the stated preference approach involves asking people directly about their hypothetical willingness to pay for safety measures that would provide them with specified reductions in risk in specified contexts. The problems associated with the revealed preference approach are identified as follows. Firstly, it can only be used when the assumptions being used are justified by the market and, as a result, new hypotheses or information cannot be used in this approach. Secondly, estimating willingness to pay to reduce risk determined from wage levels is slightly biased as the wage levels could be determined from many other factors besides risk level. A third problem is that some expenditure may have a mixture of safety and non-safety benefits, such as a higher-specification car, and it can be difficult to distinguish the safety component. The SP technique is more appropriately used when the WTP information cannot be verified from the market. The advantage of the stated preference approach is that it is possible to ask questions directly about the trade-off between risk and money and it is also possible to consider a wider and more systematic range of trade-offs than is available in the revealed preference approach.

Dissanayake and Morikawa (2000) described the advantages and disadvantages of both methods, as shown in Table 3.2.

Table 3.2 Advantages and Disadvantages of Revealed Preference and Stated Preference

Revealed Preference (RP)	Stated Preference (SP)
Based on actual market behaviour	Based on hypothetical scenarios
Choice set depends on the available alternatives	Choice set is pre-specified
Cannot provide information on new alternatives	Can be used to elicit preferences for new alternatives
Attributes are often coupled with measurement errors	Free from measurement errors
Level of attributes is limited	Can include many attributes
Correlation exists among the attributes	Correlation among the attributes can be minimized
Intangible attributes cannot be incorporated; e.g. service reliability, comfort, safety, privacy etc	Can incorporate intangible attributes
Cannot rank the preference, such as first choice, second choice	Can rank the preferences
Reliability is high	Reliability is unknown

Source: Dissanayake and Morikawa (2000)

Table 3.2 shows that the stated preference method could be used in cases where attributes are intangible and it is possible for them to be ranked. Therefore, in the case of assessing the Willingness to Pay (WTP) value, which is categorized as an intangible cost, the stated preference technique is more appropriate. Dionne and

Lanoie (2002) and Hammit (2000) take the view that, in the RP approach, the respondent will be concerned about their trade-off between risk and consumption, while in the SP method, the respondent will be asked how they would choose from a number of hypothetical situations. Moreover, Hammit (2000) asserted that the most common stated preference approach is the Contingent Valuation Method, where the respondent is asked to choose between a variety of attributes to be valued and costs to be assigned.

Bateman et al. (2002) indicated that there are two approaches that can be used in the stated preference method, these being Contingent Valuation (CV) and Choice Modelling (CM). They suggested that CV is used to obtain individual preferences, which are expressed as a monetary value. CM is based on attributes or characteristics which are embedded in the changing preferences that are offered. The study also described the CM approach as including four techniques: choice experiment, contingent ranking, contingent rating and paired comparison (Table 3.3).

Table 3.3 Main Choice Modelling Alternatives

Technique	Tasks	Welfare Consistent
Choice experiment	Choose between (usually) two alternatives vs. the status	Yes
Contingent ranking	Rank a series of alternatives	Depends
Contingent rating	Score alternative scenarios on a scale of 1-10	Doubtful
Paired comparison	Some pairs of scenarios on a similar scale	Doubtful

Source: (Bateman et al., 2002)

In order to obtain the Value of Preventing one statistical Fatality (VPF), Jones-Lee et al. (1985) and Beattie et al. (1998) used a Contingent Valuation (CV) method and asked respondents how much they would be willing to pay for a small reduction of the probability or risk of preventing non-fatal accidents. Later, Jones-Lee et al. (1995) combined the Contingent Valuation with the Standard Gamble method (SG). In the Standard Gamble method, respondents are asked to value the probability, had they suffered an injury as an impact of an accident would they be willing to take a new treatment with the condition of, had the new treatment went successful, they would return to normal condition, but if unsuccessful, their condition would worsen or dead. Hopkin and O'Reilly (1992) and Carthy et al. (1999) also described a combination method utilising both CV and SG when assessing non-fatal casualty. In this research, since the Willingness to Pay approach has not yet been employed in Indonesia, the CM method was selected because with the CM method, the questionnaire can be tailored to meet the objectives. Moreover, some parameters, which could guide the respondents, can be included in the CM's questionnaire.

There are several methods for designing the questionnaire for the purpose of eliciting the WTP value, including *open-ended, dichotomous choice* and *payment card format* (Reaves et al., 1999). Dissanayake et al. (2008) compared the advantages and disadvantages of these methods as follows:

The Open-ended Format:

In this method, the maximum amount the respondents are willing to pay for reducing a probabilistic risk reduction is asked directly. Firstly, a certain amount is suggested to the respondents in exchange for reducing a certain probabilistic risk and to reach the amount they are willing to pay, the first amount is gradually increased until the respondents refuse to pay the trade-off. The final amount chosen represents their WTP. Dissanayake et al. (2008) mentioned that this approach requires a very skilled interviewer as such a method tends to be biased.

Jones-Lee et al. (1985) conducted extensive studies and surveys. One national sample of 16 surveys was conducted for the U.K. Department of Transport in 1982 to measure the WTP to avoid a statistical fatality. When Jones-Lee et al. (1985) conducted the survey, they used the CV method and the questionnaire employed an open ended format

The Dichotomous Choice Format:

In this method, a stated amount is chosen and respondents are asked if they are willing to pay the amount for reducing a certain probabilistic risk reduction. The respondents are asked to give a simple "yes" or "no" answer. If the price is lower than their WTP, they will choose "yes", but if it is higher, they will choose "no". The National Oceanic and Atmospheric Administration (NOAA) panel recommended this method because of its incentive properties (Arrow et al., 1993).

The Payment Card Format:

In the *payment card format,* a list of specific amounts is presented to the respondents. Respondents are then asked to choose the highest value from the list that they are willing to pay. Reaves et al. (1999) and Dissanayake et al. (2008) suggested using the *payment card format* as this method exhibits desirable properties relative to the other two formats. Moreover, they also mentioned that the *payment card format* is easier for the survey respondents to understand and evaluate, thus resulting in more efficiency in the process of data collection.

In general, asking the respondents to state their WTP involves categorizing in the Contingent Valuation Method, whilst in the Choice Modelling approach, respondents are asked to make choices of the WTP for reducing the probability of the risk reduction.

3.4.2 Willingness to Pay Value in Several Countries

Willingness to Pay (WTP) value is the subjective cost in the WTP method which measures the value of life or value of injury prevention. Persson (2001) declared that the value of statistical life and value of prevention of the injury is estimated by examining the relationship between an individual's WTP for a marginal reduction of the risk of being killed or injured in a road traffic accident. Similarly, Mohd Fauzi, et.al (2004) stated that the value of life and value of prevention of the injury can be calculated by dividing the WTP by the change of the probability of risk reduction. Zhu (2003) stated more clearly that the value of a statistical life or value of prevention of the injury of the respondents is equal to the average willingness to pay divided by the reduced risk of death or risk of being injured. Furthermore, Zhu (2003) formulated the value, as shown below:

$$VSL\ (VPI) = \frac{\Delta\, WTP}{reduction\ of\ \ Risk} = \frac{\Delta\, WTP}{\Delta L(\Delta I)/\ population} = \frac{dw}{dl(di)} *\ population \qquad 3.1$$

Where:

VSL	=	Value of Statistical Life
VPI	=	Value of Injury Prevention
WTP	=	Willingness to Pay
L	=	Life
I	=	Injury

Moreover, Zhu (2003) stated that VSL and VPI can be different for any one person since the subjective cost varies from one individual to another.

Several countries are well-known for their use of the WTP method, including the UK and Sweden. Hopkin and O'Reilly (1993) pointed out that in developed countries such as the UK, the marginal cost of reducing the accident risk was used when applying the willingness to pay method. In addition, Mc Mahon (1988) stated that in the UK the costs calculated from willingness to pay were GBP 500,000 in 1988. This amount was obtained from the National Survey held in 1988, which inquired about the WTP of the respondents for safety and risk prevention. The WTP values of several countries which have applied the WTP method are presented in Table 3.3.

Table 3.3 WTP Value of Some Developed and Developing Countries

Country	Value of Statistical Life (US$)	Value of Statistical Life (GBP)
Australia	999.44	647,24
Austria	875.95	567,26
Canada	813.56	526,86
Sweden	1,246.34	807,13
Taipei - China	1,310.43	848,63
UK	877.73	568,42
USA	2,139.04	1.385,24
New Zealand	1,192.52	772,27
Malaysia	336.68	218,03

Source: Persson (2003)

Table 3.3 shows that the WTP Value of the USA is the highest, while Malaysia is the smallest. This is understandable, bearing in mind that the USA's citizen awareness of risk prevention is quite high and there have been various WTP studies in developed countries like the USA. The situation is very different in Malaysia, which is still categorized as developing country, where road users' awareness regarding their safety is still relatively low, making it understandable why Malaysia's WTP value is the lowest.

3.4.3 Summary of the Willingness to Pay Method

A survey has to be conducted to obtain the intangible cost in the WTP method, commonly known as the Willingness to Pay (WTP) value. The WTP value is the expression of statistical life or injury prevention value. Since the WTP value is categorized as non-market goods, then the stated preference method should be used. There are two methods that are commonly used to deliver the questionnaire on the SP: contingent valuation and the choice modelling method. In the Contingent Valuation Method, respondents are ask to state their WTP, whilst in the Choice Modelling approach, respondents are asked to choose the offered WTP to reduce the risk probability by using individuals' stated behaviour in a hypothetical setting.

Several countries, including the USA and Malaysia, have valued the casualty cost using the WTP method. It can be seen that the USA, as a developed country, has valued the intangible cost quite highly. On the other hand, Malaysia, as a developing country, has the lowest value, something which could be accounted for by the relatively low awareness of safety in developing countries.

3.5 Discussion of the Gross Output and Willingness to Pay Methods for Valuing Casualty Cost

With the complexity of the questionnaire, survey and analysis needed in the WTP method, it is seems reasonable that the Gross Output Method is prefered in the developing countries. On the other hand, developed countries where the awareness of the importance of safety improvement is high, tend to choose the WTP method. Aside from the fact that in WTP methods, people can express their preferences on reducing risk individually rather than expressing them using fixed percentages, as in the Gross Output Method, WTP values express higher intangible costs when assessed in comparison with the Gross Output Method.

For fatality casualties, the indirect costs (loss of productivity cost) are different in the Gross Output and the WTP methods; however, for slight and serious injury the indirect costs are the same because there is no need to consider future consumption loss.

Chapter 4: LOCATION OF STUDY

4.1 Introduction

This chapter describes the location for the study of motorcycle casualty costs in the Surabaya Metropolitan Area, including background information related to the topic. The study's location is presented in Section 4.2 and this is followed by a description of the motorcycle population and the related accidents themselves. The information given therein sets the study in context and facilitates a better understanding of problems associated with the increasing number of motorcycles and the severity of motorcyclist casualties in the Surabaya Metropolitan Area.

4.2 Case Study Location

For the purposes of this research, the study location for data collection is the Surabaya Metropolitan Area (Figure 4.1). Surabaya is the second biggest city in Indonesia and is the capital of the East Java province of Indonesia (Surabaya Statistic Office, 2008). Based on Surabaya's census survey in 2000, the population of the city was 2.6 million distributed over 31 sub-districts. Surabaya is located at 7°14'S. 112°44'E. and covers an area of 326.37 km^2.

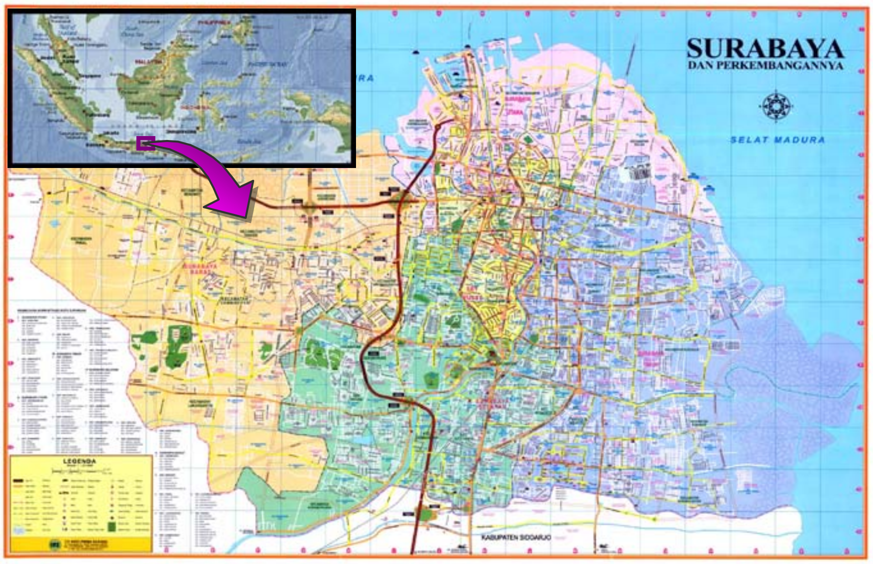

Figure 4. 1 Surabaya Metropolitan Area

4.3 Transportation Modes in Indonesia

Based on how vehicles are powered, transportation modes in Indonesia fall into two general categories: non-motorised and motorised. Like other developing countries, Indonesia has many non-motorised modes of transport, such as pedi-cab (Becak), bicycle and animal drawn vehicles, whereas motorised modes of transport include motorcycle, car, bus, mikrolet and heavy good vehicles. Presently, with the exception of bicycles, non-motorised vehicles only continue to operate in some urban areas in Indonesia; for example, horse drawn vehicles still exist in Yogyakarta as vehicles aimed to promote tourism and Becaks are popular in the city of Surabaya and Yogyakarta.

Another distinction can be made using the notion of ownership of vehicle where the mode of transport consists of two categories: private vehicles and public transport. In developed countries, public transport tends to be mass transport such as bus or light rail transit. In Surabaya, as in most of Indonesia, most forms of public transport only carry a small number of passengers such as the Becak, Ojek and Mikrolet. These modes of transport operate without a timetable, with no fixed price and no fixed route.

A Becak is a three wheeled vehicle, as shown in Figure 4.2, and is somewhat similar to a bicycle. A Becak is driven by leg power and entirely depends on the driver’s strength. In marked contrast to riding a bicycle, pedalling a Becak requires much more energy because the passenger seating carriage is in front of the driver. As the temperature in Indonesia is often over 30º C, a Becak’s driver needs power and stamina to convey the passengers efficiently and safely to their destinations; this is especially so on long journeys and on uphill roads (Figure4.3). For safety reasons, since 1997, Surabaya’s government has forbidden the Becak to travel upon main roads and therefore most Becaks can only operate in residential areas and are used mostly for short journeys. As a result, the number of Becaks decreased dramatically, though recently the number has stabilised at around 3,000 vehicles (Figure 4.4).

Figure 4.2 Becak
Source: Centre for Southeast Asian Studies (2005)[2]

Figure 4.3 Driving a Becak on an Uphill road
Source: Centre for Southeast Asian Studies (2005)

[2] This website provides a photographic archive of Indonesia. All images are copyrighted to the Centre for Southeast Asian Studies, University of Wisconsin – Madison

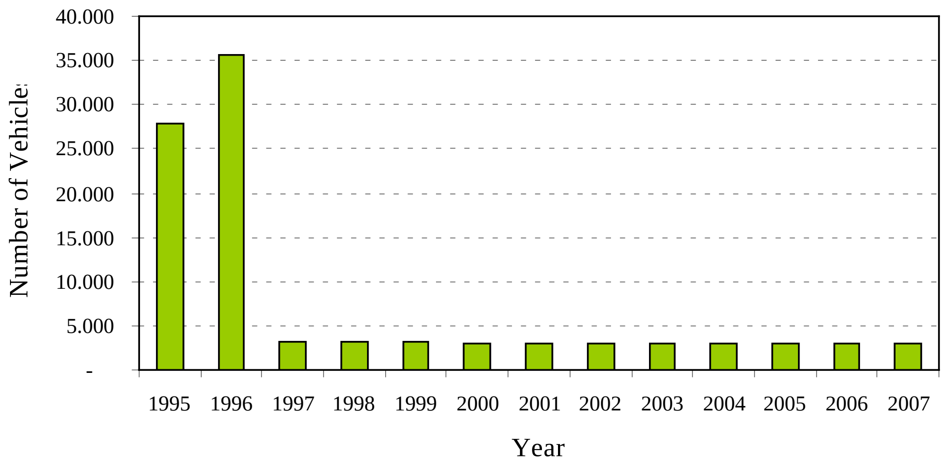

Figure 4.4 Numbers of Becaks in Surabaya
Source: Surabaya in Figures (2003)

An Ojek is a motorcycle with a rider who can be hired by a passenger. This mode of transport began to be used in Indonesia more than a decade ago. It was first used in rural areas where there is a lack of transportation infrastructure such as paved roads. The Ojek is used in such locations as a mode of transport as it is suitable for narrow and gravel types of roads. Nowadays, Ojeks can be found in most big cities in Indonesia such as Jakarta, Yogyakarta and Surabaya. In the city, the Ojek is used to carry passengers between the bus or Mikrolet stop and the passenger's house. Sometimes the Ojek is used in congested areas because motorcycles are small and more flexible in congested traffic. Most Ojeks wait for passengers close to a Mikrolet or bus stop (Figure 4.5).

Figure 4.5 Ojeks
Source: Kompas Newspaper Online (2002)

The Mikrolet is a minibus which can carry a maximum of thirteen people including the driver. This mode of transport operates on a specific route and has a flat fare; however, there is no timetable. The route can be recognised by a symbol on the body of a Mikrolet or is identified by the colour of the vehicle. As a para-transit mode, the Mikrolet can stop anywhere; however some have a pooling area where the Mikrolets stop and wait for passengers (Figure 4.6).

Figure 4.6 Mikrolet
Source: Centre for Southeast Asia Studies website (2005)

4.4 The Motorcycle as a Mode of Transportation

A motorcycle is a two wheeled motorised vehicle that is owned by an individual and is thus classed as a private vehicle. As a private vehicle, a motorcycle can be used anywhere and whenever it is needed by the owner. Due to their small size and because they have only two wheels, motorcycles tend to be easily unbalanced and present higher risks than four wheeled vehicles. However, balanced against these disadvantages, motorcycles do have advantages: namely, they can move easily in congested traffic and consume relatively less fuel to travel a given distance.

4.4.1 Background to Increasing Motorcycle Numbers in Indonesia

The ownership of motorcycles in Indonesia has risen rapidly in the last few decades. With the lack of public transport on the one hand and the need for transport on the other, people regard a motorcycle as a favourable solution. It can be used anytime and it is less expensive than other private vehicles. Moreover, a motorcycle's operating cost can be cheaper than using public transport, especially when the journey involves a transfer. Most public transport in Indonesia, such as buses and Mikrolets, use a fixed price ticket both for short or long journeys. If a transfer to another route is needed, this means that the cost could be doubled or even tripled according the number of transfers made. For example, suppose a journey needs two transfers and if the price of each ticket was IDR 3,000.00, it would mean the total cost would be IDR 9,000.00. Using a motorcycle, with a litre of fuel at a cost of IDR 4,500.00, allows a rider and a passenger to travel approximately 50 km, which can take them much further, more privately and more conveniently compared to using public transport.

Miranti (2004) described how the motorcycle volume in Indonesia had increased rapidly, especially after the financial crisis in 1998. The study identified five aspects which may explain the increase in motorcycle numbers in Indonesia; these were:

- People need motorcycles as a mode of transportation because of a lack of public transport and because the operating cost of a motorcycle is less expensive than other motorised vehicles.
- In the study in 2004, the Ojek, public transport in the form of a motorcycle taxi, was found to be more common as an alternative to mass public transport in some metropolitan areas.
- The price of a motorcycle is relatively inexpensive compared with a car and therefore more easily afforded by most people.
- A motorcycle is the most appropriate of private modes of transportation when there are infrastructure problems such as congestion and where the price of a car as a private mode of transport is beyond the average person's income
- Loans with low interest have made buying a motorcycle easier.

There are many brands of motorcycles in Indonesia, including Honda, Yamaha and Suzuki. A new motorcycle's price varies, depending on the brand (Table 4.1). It also can be seen in Table 4.1 that the price of new motorcycle is more than IDR 10,000,000. However, people can find lower prices for used motorcycle which suit their budget (Table 4.1).

Table 4. 1 Motorcycle Prices (IDR)

Type	Brand	Year	Price (IDR.)
Absolute Revo D	Honda	2010	11,800,000
Revo	Honda	2008	8,000,000
Revo	Honda	2007	7,200,000
Supra X 125 R (SW)	Honda	2010	15,425,000
Supra X	Honda	2006	8,000,000
Supra X	Honda	2005	7,000,000
Vario SW	Honda	2010	14,780,000
Vario	Honda	2007	9,600,000
Spin 125 CW	Suzuki	2010	12,850,000
Spin	Suzuki	2007	6,500,000
Spin	Suzuki	2006	5,500,000
New Shogun SD	Suzuki	2010	13,650,000
Shogun SP	Suzuki	2006	7,000,000
Shogun SP	Suzuki	2005	6,000,000
Thunder 125	Suzuki	2010	16,275,000
Thunder 125	Suzuki	2006	6,500,000
Thunder 125	Suzuki	2005	5,750,000
Vega R DB	Yamaha	2010	11,525,000
Vega R	Yamaha	2006	6,000,000
Vega R	Yamaha	2005	5,500,000
Mio CW	Yamaha	2010	12,010,000
Mio	Yamaha	2007	8,000,000
Mio	Yamaha	2006	7,000,000
Yupiter MX CW	Yamaha	2010	15,150,000
Yupiter	Yamaha	2008	9,500,000
Yupiter	Yamaha	2005	7,000,000

Source: www.harga-motor.com (February, 2010)
Note: 1 GBP = 14,000 IDR

Compared with the car prices shown in Table 4.2, motorcycle prices are approximately 10% of the price of a car and indeed second-hand motorcycles are much cheaper than this. Therefore, it can be appreciated that most middle and low-income households prefer to buy a motorcycle because it is better suited to their budget.

Table 4.2 Car Price (IDR)

Type	Brand	Year	Price (IDR)
Avanza 1.3 E M/T	Toyota	2010	133,600,000
Avanza 1.3 E M/T	Toyota	2006	106,000,000
Avanza 1.3 E M/T	Toyota	2004	94,000,000
Kijang Innova (Diesel) 2.5 M/T E	Toyota	2010	215,600,000
Kijang Innova (Diesel) 2.5 M/T E	Toyota	2006	180,000,000
Kijang Innova (Diesel) 2.5 M/T E	Toyota	2004	160,000,000
Yaris E M/T	Toyota	2010	187,900,000
Yaris E M/T	Toyota	2006	135,000,000
Grand Livina 1.5 XV M/T	Nissan	2010	179,500,000
Grand Livina 1.5 XV M/T	Nissan	2007	152,000,000
Xenia VVT-i 1.0 Li	Daihatsu	2010	123,000,000
Xenia VVT-i 1.0 Li	Daihatsu	2004	70,000,000
Terios TX M/T	Daihatsu	2010	192,000,000
Terios TS M/T Extra	Daihatsu	2010	164,000,000
Terios TS M	Daihatsu	2007	137,500,000

Source: www.harga-mobil.com (February, 2010)
Note: 1 GBP = 14,000 IDR

In 2002, the Transportation Laboratory Civil Engineering Institute of Technology, Sepuluh Nopember Surabaya, undertook a study which included data on motorcyclists' income. The income categories were divided into nine groups and, as Figure 4.7 shows, most of the motorcyclists fall into the range of income of IDR 500,000 – IDR 1,000,000. On the other hand, according to the Government of East Java Policy no 188/294/KPTS/013/2002, the minimum monthly income was IDR 453,200 which is not far from majority of motorcyclists' income, whilst the minimum monthly income in 2008 was IDR 805,500, which is in the same range as the majority of motorcyclists' incomes.

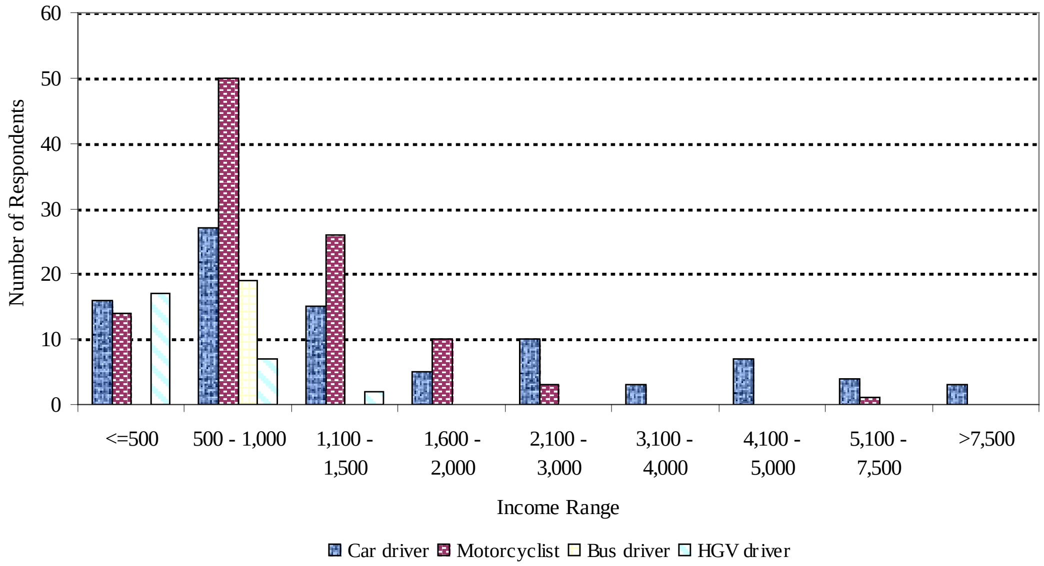

Figure 4.7 Driver's Income (x 1,000 IDR)
Source: Transportation Laboratory FTSP-ITS (2002)

4.4.2 Motorcycle Numbers in Surabaya-Indonesia

Motorcycle ownership in Surabaya has increased each year since 1992, with the exception of the economic crisis years of 1997-98 and 1998-99 when motorcycle ownership decreased by 0.48% and 2.75% respectively (Figure 4.8b). Nevertheless, the average motorcycle growth during the nine years 1992-2000 was 6.25% (Widyastuti and Bird, 2004). Moreover, Widyastuti and Bird (2004) also found that, in Surabaya, on average one in every four people has owned a motorcycle, whilst the ratio of private cars to people is 1:16. Figure 4.8 shows the number of cars, motorcycles and buses in Surabaya from 1995 to 2007. These figures show that the number of motorcycles in Surabaya has become much greater than cars and buses over the last ten years. In addition, Figure 4.8 shows that the number of motorcycles in Surabaya has increased in the last few years, especially since 2003. A recovery process from the 1998 national economic crisis may have been the trigger for the rise in motorcycle ownership. However, the increase in the ownership of motorcycles has reduced the preference of people to use public transport, including buses. For this reason, the number of buses has fallen in the last few years.

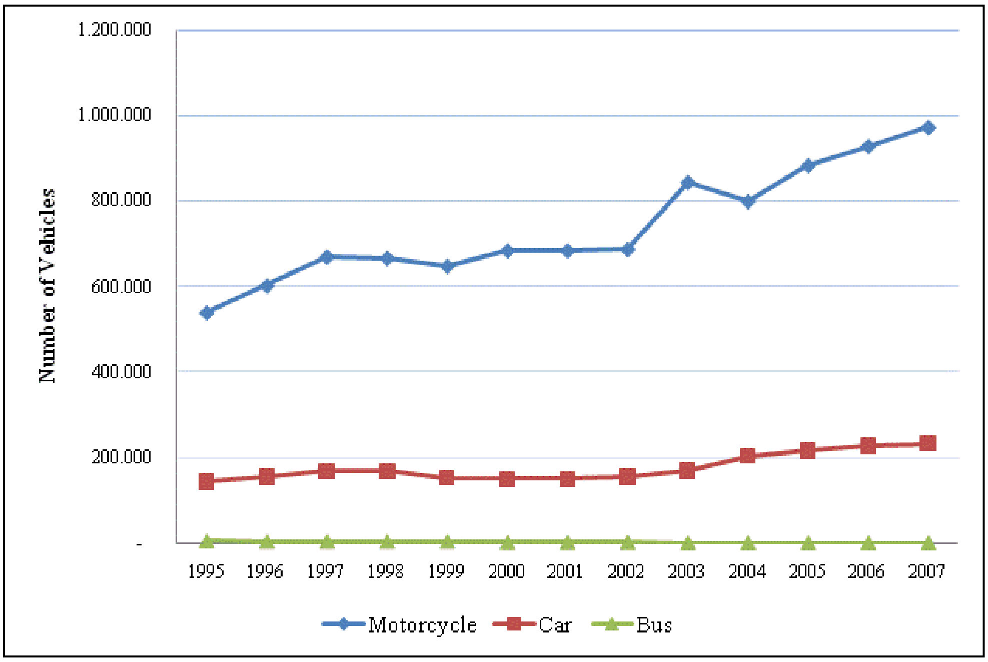

Figure 4.8 Number of Vehicles in Surabaya
Source: Surabaya Statistic Office (2008)

4.4.3 The Proportion of Motorcycles on the Road

Recently, the number of motorcycles has increased dramatically in developing countries city, including Surabaya, Indonesia. Relatively accessible price supported by an easy credit system and lack of adequate public transportation are the conditions thought to be the cause of recent motorcycle growth. Currently, the proportion of motorcycles has exceeded 50% of the total number of vehicles on the road, especially in cities like Surabaya. Table 4.3 shows motorcycle proportions in comparison with other vehicles on several roads in Surabaya.

Table 4.3 Proportion of Motorcycles on the Road (Vehicles - %)

	Light Vehicle	Highway Vehicle	Motorcycle
National			
Gresik	2790 (26%)	133 (1%)	7959 (73%)
Diponegoro	2152 (21%)	48 (1%)	7916 (78%)
Arjuno	2225 (19%)	214 (2%)	9004 (79%)
Province			
Menganti	1530 (19%)	17 (0%)	6437 (81%)
Gunungsari	2438 (19%)	45 (1%)	10216 (80%)
Mastrip	1633 (13%)	269 (2%)	10587 (85%)
Sidoarjo - Krian	1211 (18%)	99 (1%)	5543 (81%)

Source: Bina-Marga East Java Province, 2010

With the development of motorcycle capabilities in Indonesia, the result has been an increase in the distance they are able to travel. Currently, motorcycles are not only being used as a transportation mode within the city, but also as options for travelling inter-city. East Java Province Report (2009) mentioned that the distance travelled by motorcycles reached 25-50 km. The tenth biggest motorcycle travel distance desire line in East Java is shown in Figure 4.9. Figure 4.9 shows that motorcycles are not only used within the city but also between cities. This condition is in line with traffic counting results which show that on several provincial roads motorcycles have reached more than 60% of the total proportion of vehicles.

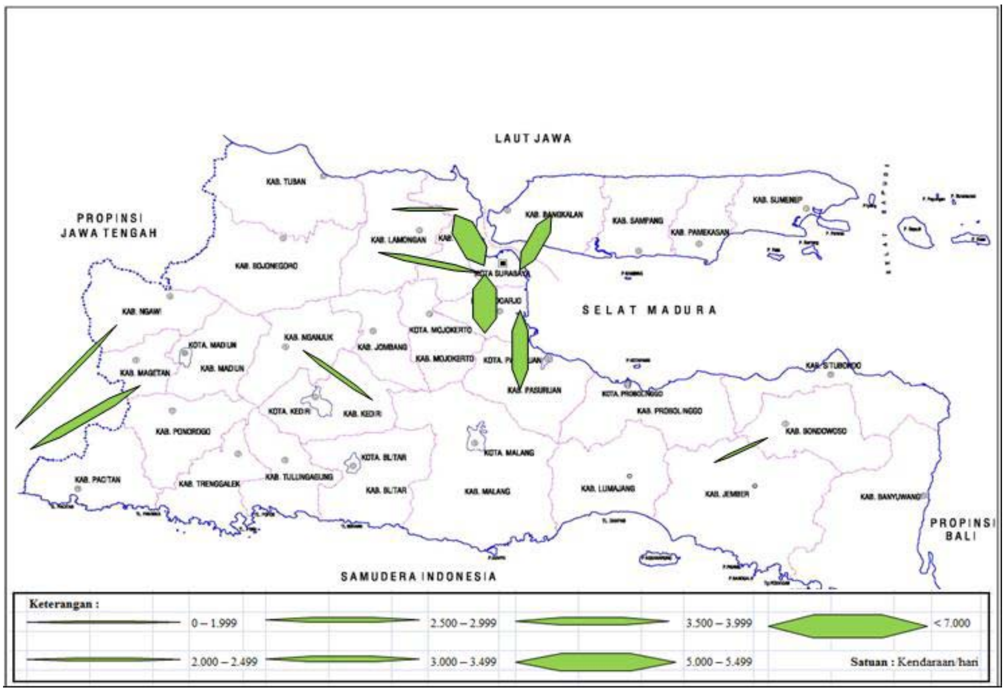

Figure 4. 9 The Tenth Biggest Desire Lines of Motorcycle at East Java Province
Source: East Java province (2009)

4.5 Motorcycle Accidents

The motorcycle is a mode of private transport that plays an increasingly important role in transporting people in some cities in developing countries, including Surabaya - Indonesia. However, as the number of motor vehicles increases, the potential for road traffic accidents also rises.

4.5.1 Number of Motorcycles Involved

In 2006, the Indonesia Transportation Authority reported that of 17,732 accidents in the whole of Indonesia, 14,223 involved motorcycles and that 36,000 people died in road accidents of which 19,000 involved motorcyclists. Figure 4.10 shows the number of vehicles involved in road traffic accidents in Surabaya. It clearly shows that motorcycles are vehicles involved in the largest proportion of traffic accidents, especially in 2006 and 2007. The high increase in 2006 and 2007 seems unusual, but this is the published Surabaya police accident record. This could be caused by system change, creating a different data gathering system or method, resulting in the dramatically different numbers when compared to the years prior to 2006-2007.

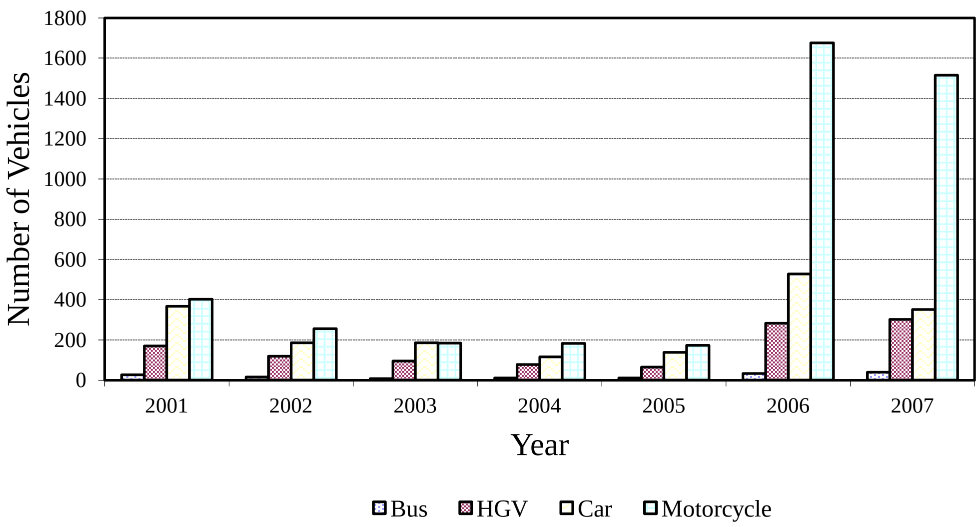

Figure 4.10 Number of Vehicles Involved in Surabaya's Traffic Accidents
Source: Surabaya Statistic Office (2008)

4.5.2 Motorcycle Accident Severity

Despite the skill required to control and ride a motorcycle safely, obtaining a motorcycle driving licence in Indonesia is easier than obtaining a car license. In addition, as riders generally do not have body protection, motorcyclists can be seen as relatively vulnerable road users. Moreover, Figure 4.11 clearly shows that the number of motorcycle casualties in 2001 was greater than that for cars. It also shows the greater severity of motorcycle casualties when compared to cars.

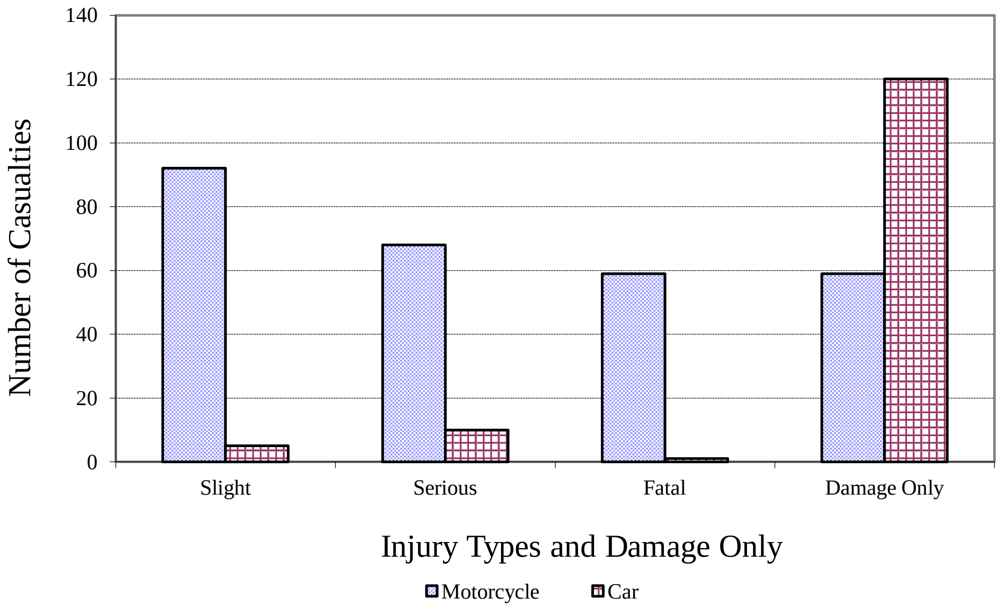

Figure 4.11 Motorcycles and Car Accident Severity in Surabaya 2001
Source: Surabaya Police Accident Records, (2002)

The biggest difference between motorcycle and car severity is the fatal category, which is 15 times higher for motorcycles. It can be concluded that the most likely outcome of a motorcycle accident will be some degree of casualty, whereas a car in a similar situation is more likely to have a damage-only accident.

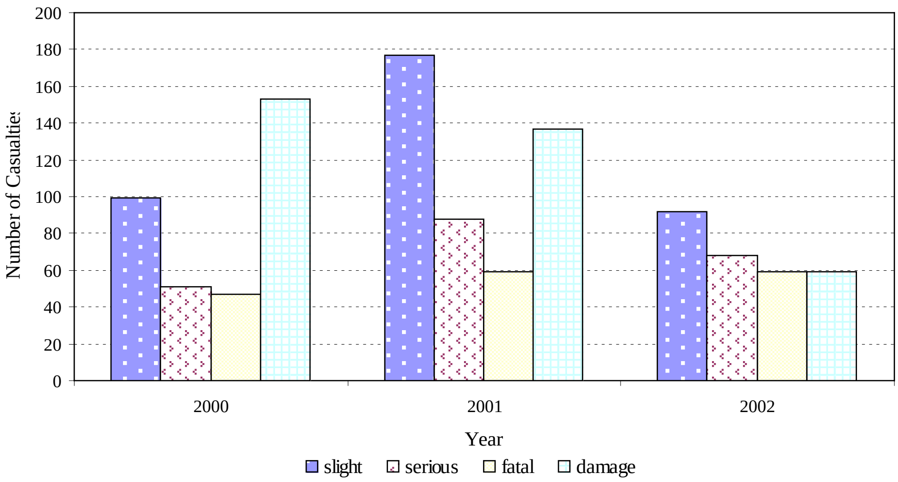

Figure 4.12 Severity of Casualties to a Motorcyclist in an Accident
Source: Surabaya Police Office (2000-2002)

Figure 4.12 shows that the slight casualties in motorcycle accidents in the year 2002 were lower than in 2000 and 2001, while the serious and fatal casualty numbers remained stable.

4.5.3 Motorcycle Accident Casualty by Age

The 319 motorcycle casualties recorded in 2001 in Surabaya comprised 58 fatalities, 87 serious injuries and 174 slight injuries. The age distribution of casualties is presented in Figure 4.13 below, showing that 41% were in the 20-29 age range. This figure may reflect the fact that motorcycle users tend to be at the younger end of the age range. This has an important impact on the indirect cost of the casualty, as it would be higher for this age group because the loss of productivity is equal to unproductive time multiplied by their wages; if the casualty dies at 25 years old, when the retirement age is 60 years old, then the unproductive time is 35 years. Moreover, if the casualty dies having achieved a good wage, then the loss of productivity will be higher than for somebody who dies when older while earning a lower income.

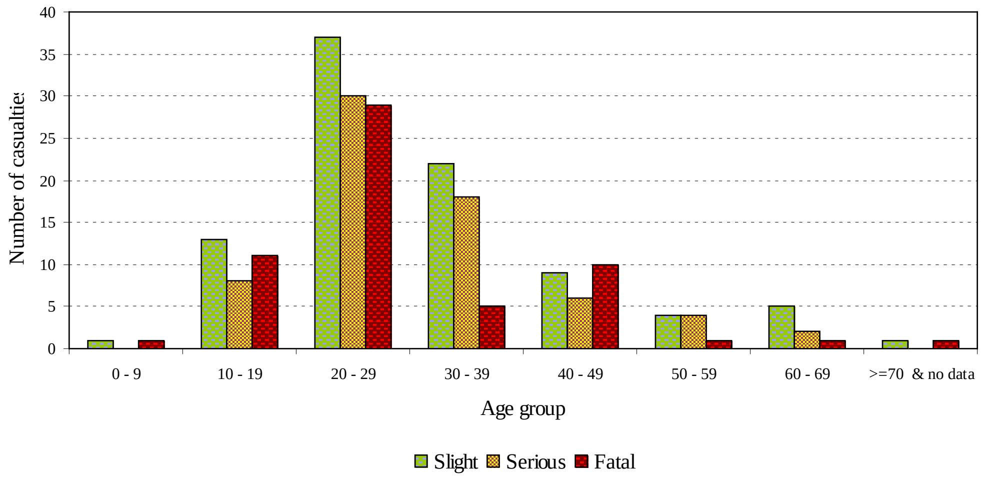

Figure 4.13 Motorcyclist Casualties in 2002 by Age Group
Source: Surabaya Police Accident Records (2002)

4.6 Summary

There are several modes of transportation being used in Indonesia, with non-motorised ones such as Pedi cab and animal drawn vehicles, and the motorised ones such as motorcycle and car. In the last ten years, motorcycle numbers have rapidly increased. Unfortunately, this has been followed by a rapid increase in the number of motorcycle accidents. In addition, motorcycle riders suffer more severe injuries than car users.

Motorcycle casualties are predominantly in the 20-29 years and 30-39 age ranges, which are classified as productive ages; therefore, in the event of accident to a member of these groups, the country and their family will suffer significantly from the loss of their productivity.

Chapter 5: METHODOLOGY OF THE STUDY

5.1 Introduction

The main aim of this chapter is to describe the methodology used in this study. In the previous chapter the methods that are widely applicable in valuing road casualties, in both developed and developing countries, have been reviewed by taking into account a number of previous studies.

As is commonly recognised, casualty cost comprises of direct, indirect and intangible cost. Recently there have been two methods commonly used for valuing casualty cost, namely the Gross Output and Willingness to Pay (WTP) methods. According to the review, it has been established that the difference between the two methods lies in the intangible cost whilst the direct and indirect costs of both methods can be calculated and analysed in the same way. For intangible cost in the Gross Output Method, there is no additional survey needed apart from the data collected to analyse the direct and indirect costs; however, that is not the case for the WTP method. Since the WTP method is currently limited to developed countries with the exception of a few recent attempts which indicate the benefit of applying such methods for developing countries, and considering the limitations of these recent attempts in developing countries such as Indonesia, this study employs a carefully designed methodological procedure to establish a value for casualties using the WTP method. However, due to the fact that previous studies in Indonesia used the Gross Output Method, this approach will also be considered in this study together with the WTP method. The following section briefly describes the methodology adopted in this study.

5.2 Methodological Framework

The methodology of this study comprised of five stages**:**

- Collection of Direct and Indirect Costs by Conducting a Survey,
- SP Survey Design,
- SP Data Collection and Data Preparation,
- SP Data Modelling using Discrete Choice Methods, and
- Casualty Valuation and Policy Analysis.

Figure 5.1 presents the framework showing how these stages interact.

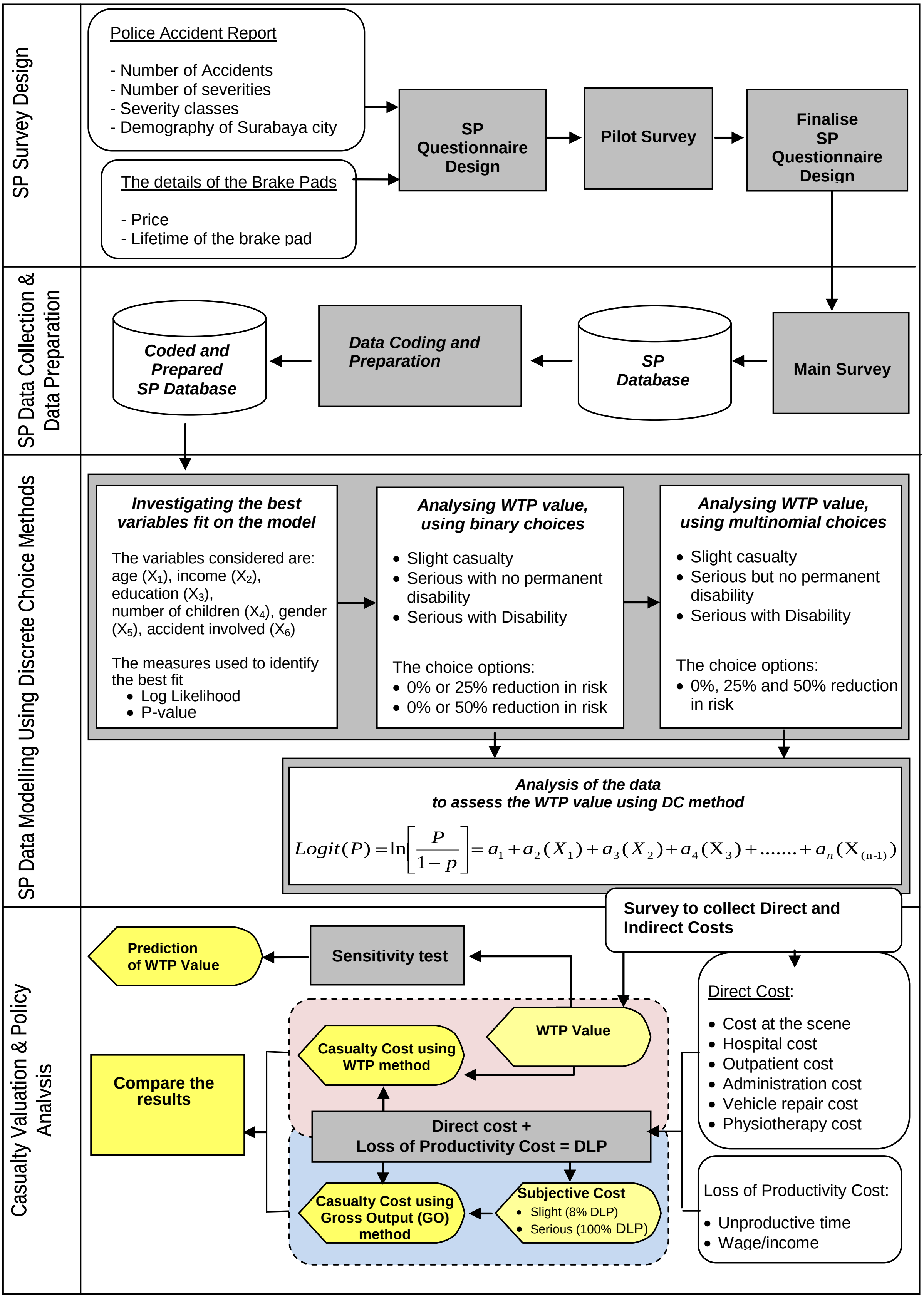

Figure 5.1 Methodology Framework

5.2.1 Collecting Direct and Indirect Costs by Conducting a Survey

At the beginning of the survey, it was made clear to all the interviewees that the aim of the survey was to collect the motorcycle casualty cost incurred as a result of their accident. They were questioned on the accidents they experienced in terms of the direct costs incurred and the productive time lost as a result of the accident.

The direct cost is the cost incurred directly from their pocket, such as medical costs, damage to vehicles and other property, administration and police costs; therefore, in the questionnaire, questions were asked regarding these particular costs that were incurred. Aside from that, questions concerning costs at the scene of accident, transport costs from the scene to the hospital, outpatient and physiotherapy costs, if any, were also asked.

As described in previous chapters, loss of productivity implies the loss of earnings of the casualty as a result of the accident. Since the loss of earnings is not directly incurred, it is categorised as an indirect cost.

With regard to loss of productivity, the data collected from the respondents included:

- Income/month
- Age
- Job
- Total length of time absent as a consequence of the accident including:
    a. Length of time spent in hospital;
    b. Time recovering at home;
    c. Length of time looking for a new job.

However, there are certain cases where the respondents may be unwilling to answer questions truthfully, especially for sensitive issues such as loss of employment and income. For this reason, secondary data is required, including:

- Minimum wages of Surabaya labour
- Average retirement age

5.2.2 Stated Preference Survey

In 2004 this study applied the Contingent Valuation (CV) method to design the Stated Preference (SP) questionnaire. The CV method has been commonly used in several studies, including those by Jones-Lee (1982), Reaves et al. (1999) and Dissanayake et al. (2008). Several kinds of information were used to construct the initial questionnaire, including number of accidents, number of severities of motorcyclist per each severity class (slight and serious) and demographic information for Surabaya City. The accident data needed to explore the details of the accidents. The payment card been used to gather the data which is a list of specific amounts was presented to the respondents one by one and they were asked to indicate whenever they were willing to choose an amount to trade-off with probability reducing risk. However, there were inconsistencies identified within this method, especially when selecting the amount that they agreed to pay. Therefore, the survey was recommenced in 2005, using the Choice Modelling (CM) instead of the CV method.

In the Choice Modelling method (CM), the questionnaire was designed and tested using a pilot survey, before being finalised for the main survey. Several forms of data information, including number of accidents, number of severities of motorcyclist per each severity class (slight and serious) and demographic information for Surabaya City were also required in order to present a picture of the probability casualty involved in the accident. To develop the CM choice scenario, it was decided that providing respondents with realistic information was more important than giving them a WTP value to choose from. Therefore, changing brake pads on a motorcycle was deemed to be appropriate. To facilitate this, information such as the price of brake pads and the lifetime of a brake pad was collected. All this data was prepared in order to construct the CM questionnaire.

The brake pad data was used to give a picture concerning the willingness to pay amount to reduce risk that was offered to the respondents. The pilot survey was conducted to assess the suitability and the effectiveness of the questionnaire. It was also important to acquire information to ensure the quality and statistical reliability of the main survey by testing the analysis procedures of the questionnaire against the time needed to collect the data.

5.2.3 Stated Preference Data Collection and Preparation

After the choice modelling questionnaire as a Stated Preference method was ready, the SP data collected from the main survey was processed and entered into a database. Subsequently, the database was coded and prepared as per the requirement of the analysis.

5.2.4 Stated Preference Data Modelling using Discrete Choice Methods

In the data analysis stage, the first step was the application of Discrete Choice to model WTP. The criterion for selecting the influencing variables on the model was based on their level of statistical significance. At this stage, the modelling of the value of the WTP consisted of two main approaches: binary and multinomial choice options. The options considered for the binary choices included 0% or 25% risk reduction and 0% or 50% reduction in risk. For the multinomial choice option, three choices, 0%, 25% and 50 % reduction in risk were considered and appropriately modelled using the Discrete Choice technique. Binary and Multinomial Logit Models were derived for all three casualty classes, namely *slight*, *serious with no disability* and *serious with disability* casualties.

Discrete choice modelling is one of the methods that can be used used for the analysis of the data relating to an individual's WTP for the reduction in risk of different types of casualty severity in a motorcycle accident. The improvements made to computer technology have made it possible to overcome some of the computational difficulties that hindered previous developments of these models. Now, there are many programmes that assist with the analysis of discrete choice models; for example, the Statistical Package for the Social Sciences (SPSS). In this research, SPSS is used because it is readily available in developing countries, including Indonesia.

Koppelman and Bhat (2006) mentioned that the result of the discrete choice models used by analysts describe preferences and choice in terms of probabilities of choosing each alternative. Moreover, as with deterministic choice theory, the individual is assumed to choose an alternative if its utility is greater than that of any other alternative. These probabilities reflect the population probabilities that people with a given set of characteristics and facing the same set of alternatives choose each of the alternatives.

The utility functions can be formulated as follow:

$$U = V + \varepsilon = \beta' x + \varepsilon \qquad 5.1$$

Where

U	=	the utility of willing to pay the amount for severity reduction.
V	=	the systematic (deterministic) component of utility of willing to pay the amount for severity reduction.
ε	=	the random (disturbance or error) component of utility of willing to pay the amount for severity reduction.
x	=	the vector of attributes that are related to the willingness to pay the amount for severity reduction.
β'	=	the vector of unknown parameters

The approach of Ben-Akiva and Lerman (1985) viewed the utility of any alternative as a random variable in which, if any alternative *i* has been selected by person *n* from choice set C_n, then the probability P_{in} is given by:

$$P_{in} = P(U_{in} \geq U_{jn} \quad \forall j \in C_n, j \neq i) \qquad 5.2$$

Where:

P_{in}	=	the probability that the individual *n* chooses alternative *i*
U_{in}	=	utility function of the individual *n* chooses alternative *i*
$\forall j$	=	all the cases, J, in the choice set C_n : the choice set of the individual *n*

Applying the formula into binary choices which symbolise the choice sets C_n as *i* and *j*, then the probability of people choosing alternative *i* is

$$P_n(i / C_n) = \Pr(U_{in} \geq U_{jn}) \qquad 5.3$$

And the probability of people choosing alternative *j* is

$$P_n(j) = 1 - P_n(i) \qquad 5.4$$

Logistically distributed, the choice probability of alternative *i* for binary logit is

$$P_n(i) = \Pr(U_{in} \geq U_{jn})$$

$$= \frac{1}{1 + e^{-\mu(V_{in} - V_{jn})}}$$

$$= \frac{e^{\mu V_{in}}}{e^{\mu V_{in}} + e^{\mu V_{jn}}} \qquad 5.6$$

While for the multinomial logit, the choice probability can be defined as:

$$P_n(i) = \frac{e^{\mu V_{in}}}{\sum_{j \in C} e^{\mu V_{jn}}} \qquad 5.7$$

Where

U_{in}	=	the utility of alternative *i* for individual *n.*
V_{in}	=	the systematic (deterministic) component of utility of *i* for individual *n.*
$P_n\ (i)$	=	the probability that the individual *n* chooses alternative *i*

Logistic regression offers a means of providing a quantitative interpretation of the estimated parameters in terms of their impact on risk reduction choices relative to ignoring prevention and the latter is taken as the baseline for comparison alternatives in this study. Washington et al. (2003) stated that the fundamental equation for logistic regression shows that when the value of one independent variable increases by one unit, while all other variables held constant, then the new probability ratio is given as follows:

$$\left(\frac{p_i}{1 - p_i}\right)_{New} = \left(\frac{p_i}{1 - p_i}\right) \exp^{\beta} \qquad 5.8$$

Thus, when the independent variable X_i increases by one unit, with all other factors remaining constant, the odds $\left(\frac{P_i}{1 - P_i}\right)$ increase by a factor of $\exp^{\beta}$ which is referred to as the odds ratio (OR). It ranges from zero to infinity and indicates the relative amount by which the odds of the outcome increase (OR greater than 1) or decrease (OR less than 1) when the value of the corresponding independent variable increases by a unit.

The choice probability of the binary model is estimated based on:

$$\boldsymbol{p} = \frac{\boldsymbol{exp^{logit(p)}}}{\boldsymbol{1 + exp^{logit(p)}}} \qquad 5.9$$

In other words

$$p = \frac{odd}{1 + odd} \qquad 5.10$$

The choice probability for the willingness to pay the amount for severity reduction can be written as follows:

$$P_n(i) = P_{yes} = \frac{e^{\beta' x_{yes}}}{e^{\beta' x_{yes}} + e^{\beta' x_{no}}} \qquad 5.11$$

Where:

$P_n(i)$ = the probability that individual *n* has chosen the option to pay the specified amount for severity reduction.

The estimation of discrete choice models involves an investigation of the beta-values (parameter estimates) and is based on the Maximum Likelihood (ML) method (Ben-Akiva and Lerman, 1985). The ML method is based on the idea that although a sample could originate from several populations, a particular sample has a higher probability of having been drawn from a certain population than from others. Therefore, the ML estimates are the set of parameters which will be generated by the observed sample most often (Ortuzar and Willumsen, 1994).

In the case of the general multinomial choice model, the maximum likelihood function is written as follows (Ben-Akiva and Lerman, 1985):

Koppelman and Bhat (2006) mentioned that the likelihood function for a sample of *T*' an individual, each with 'J' alternatives is defined as follows:

$$L(\beta) = \prod_{\forall t \in T} \prod_{\forall j \in J} P_{jt}(\beta)^{\delta_{jt}} \qquad 5.12$$

Where:

$\boldsymbol{L(\beta)}$ = Likelihood Function

$\boldsymbol{\delta_{jt} = 1}$ = chosen indicator (= 1 if *j* is chosen by individual *t* and 0, otherwise)

P_{jt} = the probability that individual *t* chooses alternative *j*

For a sample of N observations, the log likelihood function for a binary choice model that, initially proposed by Ben-Akiva and Lerman (1985), was considered for the development of an estimator of the WTP value, as follows:

$$L = \sum_{n=1}^{N} \left(y_{yes}^{n} \log\left[\frac{e^{\beta' x_{yes}}}{e^{\beta' x_{yes}} + e^{\beta' x_{no}}} \right] + y_{no}^{n} \log\left[\frac{e^{\beta' x_{no}}}{e^{\beta' x_{yes}} + e^{\beta' x_{no}}} \right] \right) \qquad 5.13$$

Where

L	=	Log Likelihood function
$y_{yes}^{n} = 1$	=	if the individual is willing to pay the amount for severity reduction
$y_{no}^{n} = 1$	=	if the individual is not willing to pay the amount for severity reduction

Furthermore, to measure the goodness of fit of the model and the data used, the Rho-squared *(ρ^2)* statistic was used. It is calculated as:

$$\rho^2 = 1 - \frac{LL(\hat{\beta})}{LL(o)} \qquad 5.14$$

Where, $LL(o)$ is the initial log-likelihood (with all parameters set at zero) and

$LL(\hat{\beta})$ is the value of log-likelihood at its maximum.

5.2.5 Casualty Valuation and Policy Analysis

In the final stage, the casualty valuation and policy analysis were carried out. Both Gross Output and Willingness to Pay (WTP) methods were applied to provide two independent estimates of the value of the casualty cost. Both methods use direct and loss of productivity cost (DLP). The information related to DLP was collected by contacting people who had experiences of accidents. The information collected included income/wage, direct costs (out of pocket) incurred and the length of unproductive time as a result of the accident.

The subjective cost (human cost) of the Gross Output is calculated by adding a fixed percentage. As mentioned in chapters 2 and 3, to obtain the subjective cost of the Gross Output the fixed percentage is multiplied by the total cost coming from the direct and indirect cost categories. The fixed percentage used varies depending on the injury type: for slight injury, the percentage used is between 8 – 10%, while for serious injury the percentage lies between 50% - 100%. In this study, the fixed percentage for slight injury was taken as 8%, after considering information obtained from previous studies, including the one from Indonesia (Asian Development Bank, 2009a). For serious casualty, it was decided to consider 100%, considering the possibility of being disabled. While the outputs obtained from the Discrete Choice Model were used to estimate the WTP value (subjective cost) in the WTP method. The casualty cost derived from both methods was compared in order to distinguish the potential differences between them. Finally, a sensitivity test was conducted to investigate the changes in the WTP value with respect to the changes in income.

5.3 Summary

In this study the Gross Output and WTP methods were applied in order to value slight and serious casualties. The difference between these methods lies in the valuing of intangible cost. In the Gross Output method, using direct and indirect cost data is sufficient to value the intangible cost. While the WTP method has to go through the SP questionnaire. Initially, the CV method was used in the SP questionnaire, but after the results were assessed, inconsistencies within the answers were identified. Consequently, the SP questionnaire was designed using the CM method and analysed with the discrete choice model. Finally, these methods were employed in this study.

Chapter 6: THE WILLINGNESS TO PAY SURVEY

6.1 Introduction

This study was commenced in 2002, at which time no accident studies in Indonesia had been conducted in the context of the Willingness to Pay (WTP) method. This study carried out the analysis using the WTP method alongside the Gross Output method to enhance the fundamental understanding of the variables that influence the value of motorcyclist casualty. Moreover, some of the secondary data was also collected from the police accident records that were available during that year.

The WPT approach looks at the amount that individuals are willing to pay to avoid an accident. The Stated Preference method was used to gather the WTP data. A number of techniques may be used in the SP approach, including Contingent Valuation (CV) and Choice Modelling (CM). Previous studies, for example Jones-Lee (1995) and Fauzi et al (2004), used the contingent valuation technique in WTP. Moreover, evidence from previous studies including Jones-Lee (1989), Hammit (2000), Johansson (2002) and Horowitz and Connell (2003), has suggested that an individual's WTP is likely to differ according to an individual's characteristics and circumstances, especially age, income and the number of children in the household. Therefore, a questionnaire was designed and used in a face-to-face survey to collect demographic information from respondents alongside the WTP questions. Individuals were asked to choose between scenarios which have an implicit risk reduction and associated monetary value.

As mentioned in the Methodology chapter, the CV method was initially used in this study to gather the SP data. Some inconsistencies appeared when proposing the monetary amounts either in ascending (from less to more) or in descending (from more to less) order. Upon realising this, it was decided that the CV method was not an appropriate method to use in the study. Therefore, it was decided to use a more advanced method; for instance, the CM technique. The CM technique allows the respondents to choose the most suitable amount from the amounts suggested, after considering the detailed information given by the CM questionnaire.

The following section will explain the methods employed to develop the CM questionnaire used in this study.

6.2 Designing the Questionnaire

In general, the questionnaire was designed to investigate the level that people are willing to pay to avoid the intangible costs that result from injury in a motorcycle accident.

Because the SP was not in common use in developing countries and the concept of WTP was new, the questionnaire was developed to make the respondents' task as easy as possible, while acquiring useful and robust data. The questionnaire was divided into three parts:

1. Nature of the Severity classes: this was both to explore the individual's perception of different types of casualty as an impact of an accident, as well to lay a foundation for specifying what sort of injuries would count as 'slight' and 'serious' used later in the questionnaire.
2. General information: this was to capture the key socio-demographic characteristics of the respondents that the literature identified as having an impact on an individual's WTP.
3. Willingness to pay choices.

6.2.1 Nature of the Severity Classes

The first issue to resolve with the respondents was to ensure that they had a clear understanding of how the seriousness of accidents was classified. This was undertaken by first asking the respondents to classify a set of typical outcomes from accidents. The range of accident outcomes was taken from the work of Jones-Lee (1985). A picture card was created to elaborate and provide consistency in the answers of respondents. There were two further reasons for asking these particular questions. Firstly, as demonstrated in the analysis below, it allows for the possibility of comparison to establish whether the respondents in Surabaya have fundamentally different views about the outcomes of accidents from those questioned in Jones-Lee

(1985). Secondly, the use of actual examples allowed the respondents to be informed that certain accidents should be regarded as ‘slight’ or ‘serious’ in their response to the SP questionnaire.

6.2.2 General Information

This section collected socio-demographic information such as age, income, number of children in the family, mode of transport used most often and whether or not a motorcycle is used, the highest level of educational achievement and whether or not they had been involved in a motorcycle accident. In this respect, the identification of income was expected to be a particular problem in Indonesia, as there is a strong culture of financial support within a family and therefore actual earned income could be substantially different from disposable income.

6.2.3 Willingness to Pay Choices

Instead of asking each individual to identify a specific WTP amount for themselves, the approach adopted was to present a series of choices which were subsequently analysed by discrete choice modelling. For each type of injury, ‘*slight*’, ‘*serious with no disability*’ and ‘*serious with disability*’, two binary options and one multiple-choice question about WTP were presented sequentially.

It was important that the questions presented to respondents were realistic and so the SP questions were framed within a scenario of ‘changing the brake pads on a motorcycle’. This was chosen because most of the motorcyclists in Indonesia, and particularly in Surabaya, tend to avoid replacing the brake pads until they are completely worn down, even though it will impact on reducing their safety. The price and characteristics of the brake pads was easily collected from any motorcycle shop.

The accident data and motorcycle numbers available from the police accident record of 2000 – 2002 were used to establish the change in risk which was used to describe what reducing the probability of an accident by 25% and 50% would mean in terms of the numbers of accidents. This enabled realistic scenarios along with associated changes in risk to be associated with plausible WTP options.

Table 6.1 The Probability of Motorcyclist Severity

Severity Classes	Probability
Serious with disability	4 in 100,000
Serious with no disability	10 in 100,000
Slight	27 in 100,000

Source: This Study

It is important in presenting scenarios to respondents that they are considered reasonable. Consequently, the WTP choices were presented to reflect at least the correct order of magnitude to support decisions, as well as making sure that the respondents were offered consistent choices. However, as WTP is not used in Indonesia, finding values in secondary data is impossible. This problem was addressed by looking at previous Indonesian studies on accident cost, based on the Gross Output method, and using evidence provided by TRL (1993). The latter suggests that WTP for the subjective cost is 3.25 times that estimated by the Gross Output method. Thus secondary data from studies of varying age (TRL (1993), Sweroad Bina Marga (1995), Yefrizon and Malkamah (2004), and Sari and Sutomo (2004)) was uplifted to 2005 values, giving a range for each of the severity types to be addressed by this questionnaire. These values were multiplied by 3.25 to generate figures more consistent with WTP valuations (TRL, 1993). The range is presented in Table 6.2. This study used the medium value.

Table 6.2 The Value of Casualty by Severity Based on the Willingness to Pay (IDR)

Severity Classes	Minimum	Medium	Maximum
Serious with disability	142,582,804	294,043,750	646,568,650
Serious with no disability	40,737,944	84,012,500	184,733,900
Slight	2,911,900	9,447,197	22,503,837

Sources: This Study
Note: GBP 1 = IDR 14,000

As two choices were to be offered in each severity class, two scenarios needed to be formulated as plausible options to be presented to the respondents. This was achieved as follows, for the case of reducing the '*serious with disability*' casualty by 25%. From Table 6.1, a reduction in 25% of a motorcycle accident which is 4/100,000 falling into this class is a 1/100,000 reduction. In the medium case, the WTP suggested by Table 6.2 for this type of accident is IDR 294,043,750. The WTP suggested by a 25% reduction is therefore 1/100,000 of IDR 294,043,750 which is

IDR 2,940. For the questionnaire, this was rounded up to IDR 3,000. This method was used for all relevant classes of accident and the figures used in the questionnaire are shown in Table 6.3.

Table 6.3 The WTP used in the Questionnaire to Reflect 25% and 50% Reductions in Risk Scenarios for a Particular Severity of Accident

Severity Classes	WTP Amount (IDR) for Reducing	
	25%	50%
Serious with disability	3,000	5,900
Serious with no disability	2,500	4,200
Slight	700	1,300

Source: This study

It was still thought that this information would be difficult for respondents to comprehend and therefore the scenarios were made more realistic by placing them in a context that could be more readily understood. Although in Indonesia motorcyclists are very familiar with the idea that changing brake pads is important to prevent accidents, they still tend to change the brake pads only when they are totally worn out. Therefore, creating the scenario of changing the brake pads on the motorcycle was used in the questionnaire to represent an amount of money that respondents would be willing to pay. Manufacturers suggest that the brake pads should be changed every 8,000 km and this entails a cost of around IDR 50,000 for original spare parts. This was translated into a cost per km and used with the different WTP figures to identify the number of km below 8,000 that reflect the changes in risk. These are shown in Table 6.4.

Table 6.4 Brake Pad Change Interval Suggested for Reducing Accident Risk

Severity Classes	Changing Pad Regularly (km) Suggested for	
	25%	50%
Serious with disability	7,500	7,000
Serious with no disability	7,600	7,300
Slight	7,880	7,790

Source: This study

This led to cards being produced to show respondents. An example of a card for a 25% reduction in risk for a *slight* injury is shown in Figure 6.1. Moreover, also included in the questionnaire was a potential speed up to which the motorcyclist could travel if good brake pads were maintained.

Criteria	Option A	Option B
Maximum possible speed (km/hr)	70	60
Change brake pad at every (km)	7,880	8,000
Probability of slight injury	20 in 100,000	27 in 100,000
Additional cost (IDR)	700	0
Which alternative do you prefer?	A	B
What will you give up to pay for it?		

Figure 6.1 Binary Questionnaire for Slight Injury
Source: This study

The questionnaire was translated into the Indonesian language for collecting the data and face to face interviews were carried out with motorcycle users or with people who had experience of an accident involving a motorcycle in Surabaya, Indonesia.

6.3 Data Collection

A pilot survey for the main survey which used the CM method was conducted in October 2005 – February 2006. This revealed that asking respondents to consider 18 binary and 3 multiple choice questions was too much as they lost concentration, resulting in a lack of consistency in their responses. It was clear that the number of options needed to be reduced with a view towards bringing the interview time down to substantially below 30 minutes. Otherwise, the pilot survey did not identify any shortcomings. In the main survey, which was carried out between March and July 2006, only 6 binary and 3 multiple choice questions (appendix) were presented during the interview. The WTP values reflect the conditions of that specific year.

6.4 Description of Respondents' Data

One hundred and eighty two responses were obtained. The sample was predominantly male (73%) and 46% of the sample fell into the age range 20-29, (Figure 6.2). This is in line with the total number of accidents as reported in the police accident records, which revealed that motorcyclist casualties are predominantly between 20 and 29 year old (Refer Chapter 3, Figure 3.13).

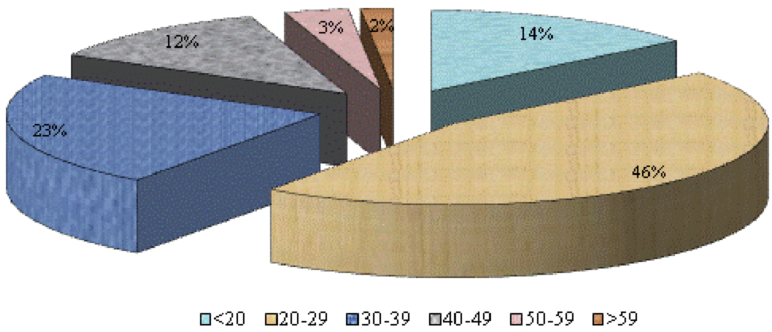

Figure 6. 2 Representation of Respondents by Age in Years
Source: This study

Grouping the sample into three income groups showed that 75% of respondents had incomes of less than IDR 1,000,000. This result is consistent with a previous survey carried out by the Transportation Laboratory FTSP-ITS (2002), which reported the income of motorcyclist as being between IDR 500,000 – IDR 1,000,000 in 2002 (see Chapter 3, Figure 3.7).

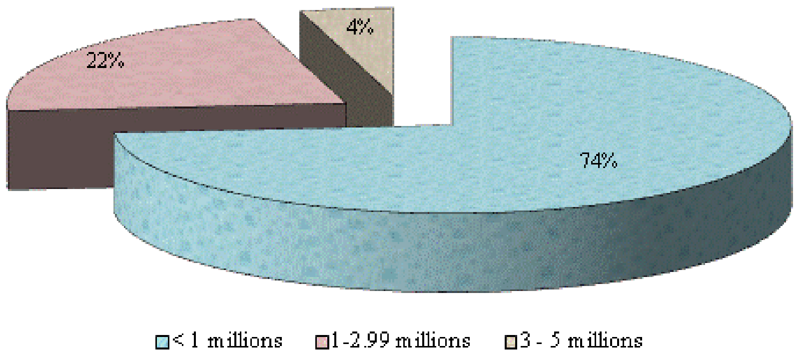

Figure 6.3 Respondents Grouped by Monthly Income (IDR)
Source: This study

6.5 Results Relating to the Different Types of Severity

Table 6.5 presents the respondents' opinions on the types of severity from Jones-Lee (1985) compared to this study. Descriptively, the figures from the two studies appear to be different. Direct comparison of these two data sets is difficult, because the observation in each cell has to be 5 or more. However, a high level comparison was carried out by considering only two classifications: not serious and all others. A chi-squared and proportion tests were used to establish whether the pattern of responses in each classification (not serious and all others) for UK respondent presented on the Jones-Lee (1985) study is statistically significant from this study. Moreover, Science.jrank.org, (2010) informed that the chi-square test is the most commonly used method for comparing frequencies or proportions.

Table 6.5 Comparison of UK and Indonesian Studies (in Number (%))

Picture	Description	Study	Not serious	Serious but death worse	As bad as death	Slightly worse than death	Much worse than dead	Very much worse than death
	Cut and bruised but can leave hospital after couple of days and recover fully within a month.	**Jones-Lee**	897 (81.3)	206 (18.7)	0.0	0.0	0.0	0.0
		This study	182 (98.6)	3 (1.4)	0.0	0.0	0.0	0.0
	Breaking an arm.	**Jones-Lee**	696 (63.1)	40,480 (36.7)	110 (0.1)	110 (0.1)	0.0	0.0
		This study	32 (17.1)	148 (80.2)	3 (1.4)	3 (1.4)	0.0	0.0
	In hospital for a year, but recovers fully.	**Jones-Lee**	169 (15.3)	923 (83.7)	7 (0.6)	4 (0.4)	0.0	0.0
		This study	8 (4.3)	138 (74.5)	19 (10.3)	12 (6.6)	4 (2.0)	4 (2.3)
	Lose a leg.	**Jones-Lee**	35 (3.2)	956 (86.7)	68 (6.2)	26 (2.4)	13 (1.2)	3 (0.3)
		This study	4 (2.0)	88 (47.5)	45 (24.2)	24 (13.1)	16 (8.4)	9 (4.7)
	Lose an eye.	**Jones-Lee**	34 (3.1)	982 (89.0)	55 (5.0)	21 (1.9)	7 (0.6)	3 (0.3)
		This study	4 (2.0)	81 (43.9)	47 (25.5)	28 (15.1)	16 (8.8)	8 (4.5)
	Badly scarred for life and in hospital for a year.	**Jones-Lee**	34 (3.1)	931 (84.4)	85 (7.7)	33 (3.0)	13 (1.2)	6 (0.5)
		This study	3 (1.4)	76 (41.1)	41 (22.4)	33 (18.1)	16 (8.8)	15 (8.1)
	Confined to a wheelchair for the rest of your life.	**Jones-Lee**	3 (0.3)	533 (48.3)	306 (27.7)	119 (10.8)	96 (8.7)	47 (4.3)
		This study	2 (0.9)	81 (43.4)	31 (16.9)	37 (20.0)	22 (12.0)	13 (6.8)
	Permanently bed-ridden.	**Jones-Lee**	2 (0.2)	403 (36.5)	368 (33.4)	131 (11.9)	124 (11.2)	76 (6.9)
		This study	1 (0.5)	14 (7.5)	51 (27.5)	22 (12.1)	44 (23.9)	53 (28.5)

Source: This Study Compared to that Carried Out by Jones-Lee (1985)

According to Table 6.5, the first three cases (injuries of being cut and bruised or breaking an arm or being in hospital for a year, but fully recovering) contain many empty cells with respect to the classification of serious injury. For the last two injuries, the chi square test is also unreliable as the cells of the 'not serious' classification have a value which is less than 1. As a result, alternative tests were used to investigate respondents' perception of these injuries. Alternative statistical tests were performed to explore whether the peoples' pereceptions in this study were significantly different or similar to the study conducted by Jones-Lee (1985). For this reason, the proportion test was used instead of the chi square test. Moreover, Stattrek.com (2010) informed that two-proportion z-test**,** is appropriate to determine whether the difference between two proportions is significant, when the sampling method for each population is simple random sampling and the samples are independent The difference between the proportion of people who identify "cut and bruised" or "the breaking of an arm" or "being in hospital for a year but fully recovering" as "not serious injuries" was investigated by first considering the data from both studies.

Table 6.6 Statistical Difference Test of Cuts and Bruises, Breaking an Arm and a Year in Hospital

Type of severity		Jones-Lee (n=1103)		This study (n=185)		z
Picture	Description	$\hat{p}_1$	$\hat{q}_1$	$\hat{p}_2$	$\hat{q}_2$	
	Cut and bruised, but can leave hospital after a couple of days and recover fully within a month.	0.813	0.187	0.986	0.014	-5.09*
	Breaking an arm.	0.631	0.369	0.171	0.829	11.5*
	In hospital for a year, but recovers fully.	0.153	0.847	0.043	0.957	3.92*

Note: Z is a value for test of difference between two proportions at 5% level of significance.
Source: This study

Consequent scrutinisation of the results identified that the proportions were significantly different at a 5% level of significance (Table 6.6). The possible reason for this may be due to the variations in peoples' perceptions when taking into account the 'developed' and 'developing' contexts in which they live.

For the injuries of losing a leg, losing an eye or being badly scarred and in hospital for a year, a chi square test was undertaken which identified that the distribution of responses received in Jones-Lee (1985) study by classification is significantly different from those responses received in this study (with p-values of 0.000). These are reported in Table 6.7.

Table 6.7 Statistical Difference Test of Losing a Leg, Losing an Eye and being Badly Scarred for Life

Picture	Description	χ^2	Degree of freedom (df)	P-value
	Lose a leg.	206.012	5	0.000
	Lose an eye.	283.996	5	0.000
	Badly scarred for life and in hospital for a year.	240.752	5	0.000

Source: This study

A chi-square test was carried out with respect to the degree of seriousness identified by the respondents (ie ignoring any responses to the classification 'not serious'). The outcome of this test identified that the distribution of classification of seriousness by respondents in Jones-Lee's study was significantly different from the responses in this study (with p-values of 0.000). These are reported in Table 6.8. The chi-square tests were carried out using numbers instead of the percentages.

Table 6.8 Statistical Difference Tests of Results of Casualty classified as Confined to Wheelchair and Permanently Bed Ridden

Picture	Description	χ^2	Degree of freedom (df)	P-value
	Confined to a wheelchair for the rest of your life.	22.027	4	0.000
	Permanently bed-ridden.	135.349	4	0.000

Source: This study

One of the motivations for undertaking this study in Indonesia was because it was thought that the transfer of values derived in developed countries would not necessarily be appropriate in a developing country. The results here demonstrate that, for whatever reason, there is a significant difference in views between UK and Indonesia citizens' perceptions of the classifications of seriousness of injuries. Therefore the casualty and accident cost applied in Indonesia has to be different to that in the UK.

6.5.1 Slight Casualty

Figure 6.4 shows the structure of the choices for WTP offered to respondents in the questionnaire relating to the hypothetical scenario of reducing the risk of a *slight* casualty following a motrocycle accident. Two sets of binary choices for 25% and 50% were given in addition to the multinomial choices.

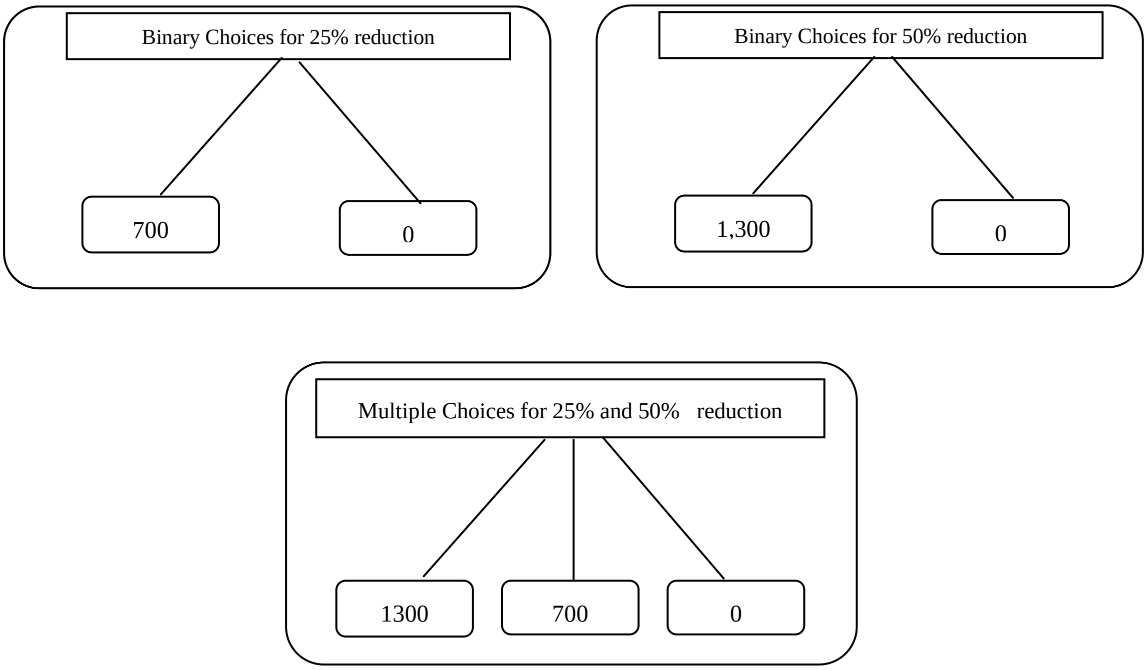

Figure 6.4 Options for Reducing the Risk of Slight Casualty to a Motorcyclist

Table 6.9 tabulates the percentages of respondents that fall into various categories for '*slight*' motorcycle casualty. It presents the data for both the binary and the multinomial choice scenarios. Comparing the two binary choices, the similarity of the percentages in each category suggests that respondents found it easy to make a choice when faced with the two options of WTP or not paying. On the other hand, to distinguish between the amount they might pay (WTP IDR 700 or WTP IDR 1,300) was difficult when the respondents were asked to make a decision on multinomial choices and the responses were divided more evenly among the three categories of IDR 1,300, IDR 700 and IDR 0.

Table 6.9 Responses (%) for WTP for Reduction of Risk of Slight Casualty According to Demographic Characteristics

Variables	Binary-1 (IDR)		Binary-2 (IDR)		Multinomial choices (IDR.)		
	0	700	0	1,300	0	700	1,300
Age (Year)							
<20	1.65	12.64	1.65	12.64	1.65	0.55	12.09
20-29	9.89	35.71	9.89	35.71	8.24	10.99	26.37
30-39	6.59	16.48	7.69	15.38	6.59	3.85	12.64
40-49	2.75	9.34	2.75	9.34	2.20	2.20	7.69
50-59	1.10	2.20	1.65	1.65	1.10	0.55	1.65
>59	0.55	1.10	0.55	1.10	0.55	0.00	1.10
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54
Income (IDR)							
< 1million	18.13	55.49	19.23	54.40	18.13	15.93	39.56
1-2.99 million	4.40	17.58	4.40	17.58	2.20	1.65	18.13
3 - 5 million	0.00	4.40	0.55	3.85	0.00	0.55	3.85
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54
No of children							
0	13.19	45.60	14.84	43.96	12.09	9.34	37.36
1	4.95	8.24	3.30	9.89	4.40	3.85	4.95
2	2.75	11.54	4.40	9.89	2.75	2.20	9.34
3	1.65	8.24	1.65	8.24	1.10	2.75	6.04
4	0.00	2.75	0.00	2.75	0.00	0.00	2.75
5	0.00	1.10	0.00	1.10	0.00	0.00	1.10
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54
Motorcycle user							
Yes	18.68	53.30	19.78	52.20	15.38	17.03	39.56
No	3.85	24.18	4.40	23.63	4.95	1.10	21.98
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54
Education							
Max at High school	13.19	35.71	13.19	35.71	13.74	14.29	20.88
Student S1	7.69	24.73	8.24	24.18	6.59	1.65	24.18
Graduate S1	1.65	17.03	2.75	15.93	0.00	2.20	16.48
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54
Accident involved							
Yes	13.74	50.00	15.38	48.35	10.99	12.09	40.66
No	8.79	27.47	8.79	27.47	9.34	6.04	20.88
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54
Married							
Yes	13.74	38.46	13.19	39.01	12.09	10.44	29.67
No	8.79	39.01	10.99	36.81	8.24	7.69	31.87
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54
Gender							
F	3.85	22.53	5.49	20.88	3.30	2.20	20.88
M	18.68	54.95	18.68	54.95	17.03	15.93	40.66
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54
Self supporting							
Yes	18.13	56.59	19.23	55.49	15.38	17.58	41.76
No	4.40	20.88	4.95	20.33	4.95	0.55	19.78
Total Responses (%)	22.53	77.47	24.18	75.82	20.33	18.13	61.54

Source: This study

In terms of WTP, Table 6.9 shows that over 77% are willing to pay IDR 700, and this decreases slightly to 75.24% as the amount suggested increases to IDR 1300; while on the multinomial choices, it shows that more than 79% are willing to pay something. The way in which age has an impact on choice is clearly evident. The proportions' pattern, with the number of children in the household and income, shows that there is a decrease in WTP to nothing as the number of children in the household increases.

6.5.2 Serious with no Disability

Figure 6.5 shows the structure of the choice for WTP offered to repondents in the questionnaire, relating to the hypothetical scenario of reducing the risk of a *serious with no disability* following a motorcycle accident. Two sets of binary choices for 25% and 50% were given and these same two were also were presented in a multinomial choice environment.

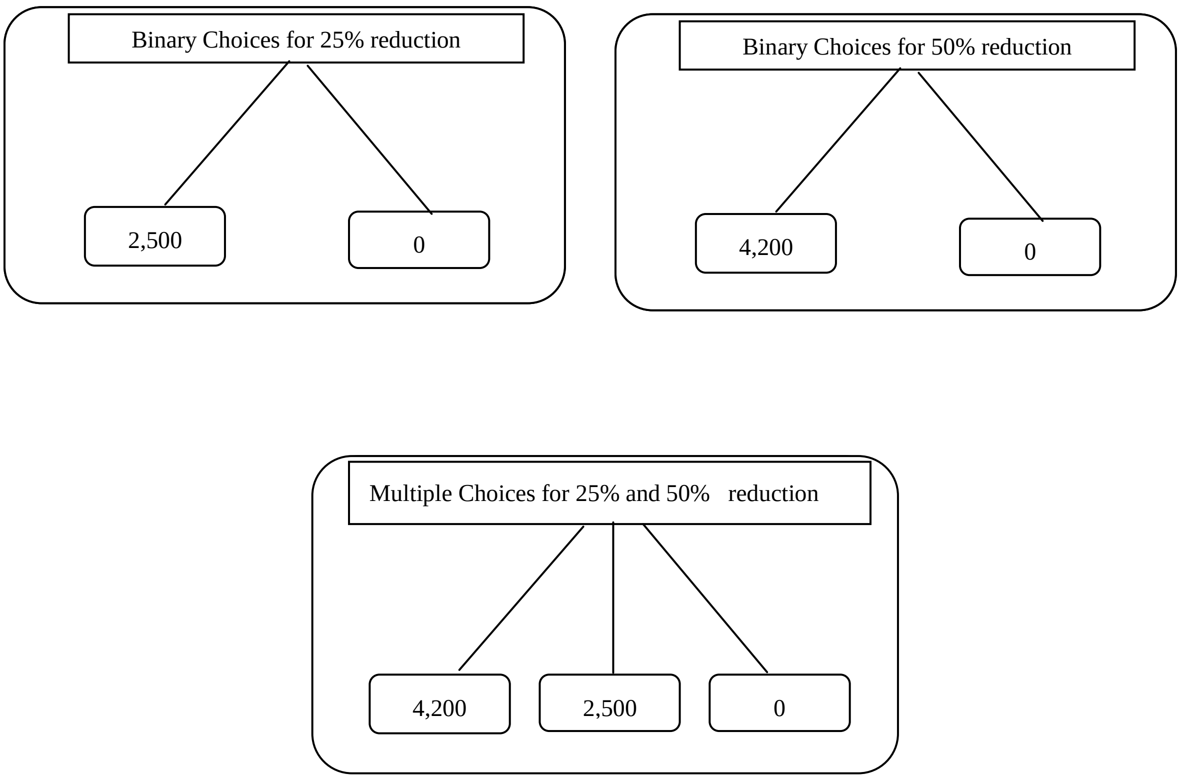

Figure 6.5 Options for the Reduction the Risk of Serious with no Disability Casualty to a Motorcyclists
Source: This study

Table 6.10 tabulates the percentages of respondents by WTP for reducing the *serious with no disability* category of motorcycle injuries. It presents the data for both binary and the multiple choice scenarios. Comparing the two binary choices reveals that the majority of respondents are willing to pay on both the binary choices. When the respondents were asked to make a decision based on a multinomial choice, the responses differentiate among the categories of IDR 4,200; IDR 2,500 and IDR 0. It appears that some of responses of IDR 0 are quite similar to those for the first binary choice.

Table 6.10 Responses (%) for the WTP for Reduction of Risk of Serious with no Disability Casualty According to Demographic Characteristics

Variables	Binary-1 (IDR)		Binary-2 (IDR)		Multinomial choices (IDR)		
	0	2,500	0	4,200	0	2,500	4,200
Age (Year)							
<20	2.20	12.09	4.40	9.89%	1.10%	2.75	10.44
20-29	6.59	39.01	18.68	26.92%	4.95%	17.03	23.63
30-39	6.04	17.03	9.34	13.74%	6.04%	8.24	8.79
40-49	2.75	9.34	3.30	8.79%	2.75%	2.20	7.14
50-59	1.10	2.20	1.65	1.65%	1.10%	0.55	1.65
>59	0.55	1.10	0.55	1.10%	0.55%	0.00	1.10
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75
Income (IDR)							
< 1 million	16.48	57.14	33.52	40.11%	14.84%	25.82	32.97
1-2.99 million	2.75	19.23	3.85	18.13%	1.65%	4.40	15.93
3 - 5 million	0.00	4.40	0.55	3.85%	0.00%	0.55	3.85
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75
No of children							
0	10.44	48.35	22.53	36.26	8.24	17.58	32.97
1	4.40	8.79	6.59	6.59	3.85	4.95	4.40
2	2.75	11.54	6.59	7.69	2.75	4.95	6.59
3	1.10	8.79	1.10	8.79	1.10	2.75	6.04
4	0.55	2.20	1.10	1.65	0.55	0.55	1.65
5	0.00	1.10	0.00	1.10	0.00	0.00	1.10
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75
Motorcycle user							
Yes	14.84	57.14	27.47	44.51	12.64	26.37	32.97
No	4.40	23.63	10.44	17.58	3.85	4.40	19.78
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75
Education							
Max at High school	13.74	35.16	24.73	24.18	10.99	20.33	17.58
Student S1	4.95	27.47	10.44	21.98	5.49	5.49	21.43
Graduate S1	0.55	18.13	2.75	15.93	0.00	4.95	13.74
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75
Accident involved							
Yes	12.09	51.65	23.63	40.11	10.44	18.13	35.16
No	7.14	29.12	14.29	21.98	6.04	12.64	17.58
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75
Married							
Yes	12.09	40.11	20.88	31.32	10.99	17.03	24.18
No	7.14	40.66	17.03	30.77	5.49	13.74	28.57
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75
Gender							
F	3.30	23.08	8.24	18.13	3.85	3.85	18.68
M	15.93	57.69	29.67	43.96	12.64	26.92	34.07
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75
Self supporting							
Yes	14.84	59.89	28.57	46.15	12.64	27.47	34.62
No	4.40	20.88	9.34	15.93	3.85	3.30	18.13
Total Responses	19.23	80.77	37.91	62.09	16.48	30.77	52.75

Source: This study

Similar to the *slight* casualty category, Table 6.10 also shows that over 80% are willing to pay IDR 2,500 and this decreases slightly to 62.09% as the amount suggested increases to IDR 4,200, whilst on the multinomial choices, it shows that more than 81% are willing to pay something.

The way in which age, income and education has an impact on choice can be clearly seen. It can also be observed that having already been involved in an accident increases the willingness to pay.

6.5.3 Serious with Disability

The choices of WTP offered to respondents in the questionnaire relating to the hypothetical scenario of reducing the risk of a *serious with disability* following a motorcycle accident was also structured into two binary choices for 25% and 50% and in a multinomial choice environment (Figure 6.6).

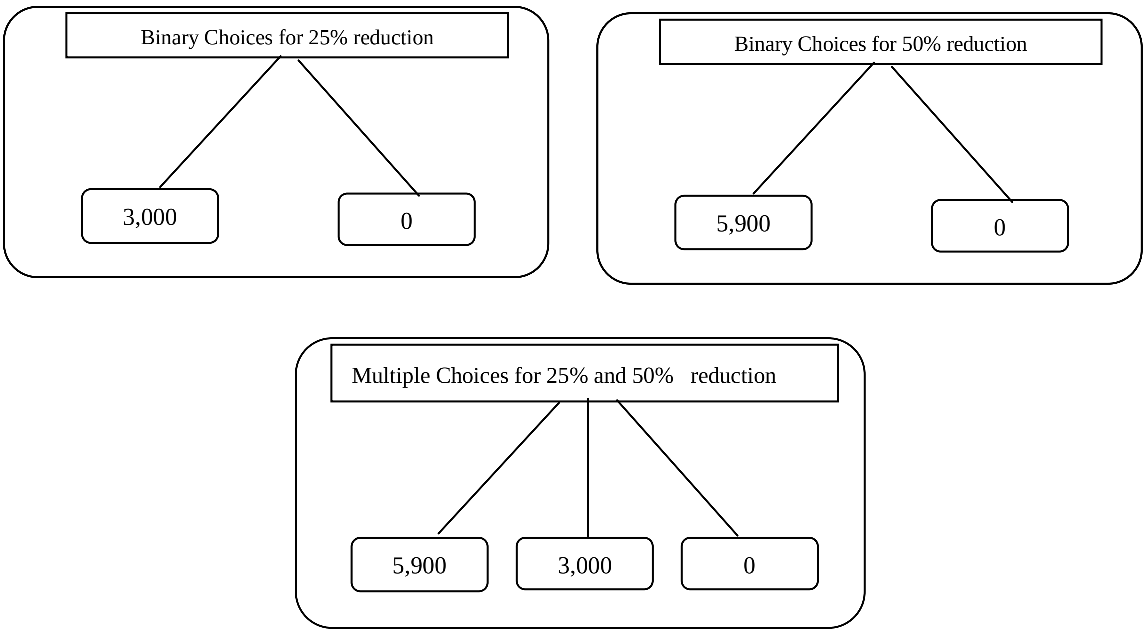

Figure 6.6 Options for Reducing the Risk of Serious with Disability Casualty to a Motorcyclists
Source: This study

The percentages of respondents in willingness to pay categories for reducing the risk of *serious with disability* to motorcyclist are shown in Table 6.11. Once again, it presents the data for both binary choice scenarios and the multinomial choice scenario. Comparing the two binary choices shows that the majority of the responses are willing to pay on both the binary choices. When forced to make a decision on a multinomial choices, the respondents chose a WTP IDR 5,900 which means reducing by 50% the incidence of *serious with disability* casualty to motorcyclists.

Table 6.11 Responses (%) for WTP for the Reduction of Risk of the Serious with Disability Casualty According to Demographic Characteristics

Variables	Binary-1 (IDR)		Binary-2 (IDR)		Multinomial choices (IDR)		
	0	3,000	0	5,900	0	3,000	5,900
Age (Year)							
<20	3.30	10.99	3.85	10.44	1.65	2.20	10.44
20-29	5.49	40.11	15.38	30.22	4.95	12.64	28.02
30-39	6.04	17.03	9.34	13.74	6.59	6.04	10.44
40-49	3.30	8.79	4.40	7.69	3.30	2.75	6.04
50-59	0.55	2.75	0.55	2.75	0.55	0.00	2.75
>59	0.55	1.10	0.55	1.10	0.55	0.55	0.55
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58
Income (Rp.)							
< 1million	17.03	56.59	30.77	42.86	14.84	20.33	38.46
1-2.99 million	2.20	19.78	3.30	18.68	2.75	3.30	15.93
3 - 5 million	0.00	4.40	0.00	4.40	0.00	0.55	3.85
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58
No of children							
0	10.99	47.80	19.23	39.56	8.79	12.64	37.36
1	3.30	9.89	4.95	8.24	3.30	4.40	5.49
2	2.75	11.54	6.04	8.24	3.30	2.75	8.24
3	1.65	8.24	2.20	7.69	1.65	3.30	4.95
4	0.55	2.20	1.10	1.65	0.55	0.55	1.65
5	0.00	1.10	0.55	0.55	0.00	0.55	0.55
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58
Motorcycle user							
Yes	14.29	57.69	23.63	48.35	13.74	19.23	39.01
No	4.95	23.08	10.44	17.58	3.85	4.95	19.23
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58
Education							
High school and	13.19	35.71	24.73	24.18	12.09	17.58	19.23
Student S1	5.49	26.92	7.14	25.27	4.40	3.85	24.18
Graduate S1	0.55	18.13	2.20	16.48	1.10	2.75	14.84
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58
Accident involved							
Yes	11.54	52.20	19.78	43.96	10.99	14.84	37.91
No	7.69	28.57	14.29	21.98	6.59	9.34	20.33
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58
Married							
Yes	10.99	41.21	18.68	33.52	11.54	13.74	26.92
No	8.24	39.56	15.38	32.42	6.04	10.44	31.32
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58
Gender							
F	3.30	23.08	6.59	19.78	2.75	3.30	20.33
M	15.93	57.69	27.47	46.15	14.84	20.88	37.91
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58
Self supporting							
Yes	14.29	60.44	25.82	48.90	13.74	21.43	39.56
No	4.95	20.33	8.24	17.03	3.85	2.75	18.68
Total Responses	19.23	80.77	34.07	65.93	58.24	24.18	17.58

Source: This study

Table 6.11 shows that over 80% are Willing to Pay for reduction of risk of casulaties belonging to the serious with disability category, although on binary choices the percentage of respondents willing to pay on the higher sum of WTP (IDR 5,900) is lower than those willing to pay the lower sum of WTP (IDR 3,000), with the exception of respondents who are over 59 years old or have an income in the range IDR 3 – 5 millions per month; whilst on the multinomial choices, it shows that more than 82% are willing to pay either IDR 5,900 or IDR 3,000. As before, the use of a motorcycle and having had an accident makes a respondent willing to pay a higher amount of money for the risk reduction with respect to serious with disability casualty type.

6.6 Discussion and Summary

The results relating to the different perception of types of severity, as shown in Section 6.5, demonstrated that there is a significant difference in views on the classifications of the seriousness of injuries for respondents from Indonesia, as a developing country, compared to the UK, as a developed country. The fact that respondents had such differing views means that valuing casualty and accident costs in the developing country should not be the same as in a developed country. This is contrary to the situation that exists at present. Currently, the human cost of casualty is valued by using the gross output method with a fixed percentage derived from experience in the UK (a developed country), an approach which is clearly inappropiate.

An essential part of the next stage of this study was to use the WTP questionnaire as data base and thus to elicit the willingness of Indonesian people to pay for the the prevention of various degrees of casualty. Two binary and one multiple choice questions on each type of casualty were used to elicit the willingness of people in Surabaya city in Indonesian to pay for the prevention of motorcyclist casualties.

The results of the descriptive data for the WTP for *slight*, *serious with no disability* and *serious with disability* revealed that over 77% are willing to pay something. Moreover, the binary choice cases show that people's WTP slightly decreases as the amount increases. The impact of age on choice can also be seen clearly. The pattern with respect to the number of children in the household shows that there is a decrease in being Willing to Pay to nothing as the number of children in the household increases. The comparison between slight and serious casualty shows that the percentage of people willing to pay something increases. This could give the impresion that people's preferences on protecting their safety increase as the severity increases. The descriptive data does not necessarily reflect the model of WTP value, taking, for example, the variable of motorcycle user, the descriptive data from respondents shows that over 77% are willing to pay something and that motorcycle users are more willing to pay than non-motorcycle users, but the variable of motorcycle user would not necessarily be of significance in the model of WTP value. Therefore it is important this data is analysed in more detail with the logit model, as described in the next chapter. The model would then be available to determine the probability of people choosing to pay for a reduction in the risk injuries to motorcyclists.

Chapter 7: ANALYSIS OF THE WILLINGNESS TO PAY VALUE USING DISCRETE CHOICE MODELS

7.1 Introduction

The questionnaire which was designed to identify people's willingness to pay for risk reduction with particular emphasis on motorcycle accidents using the Willingness to Pay (WTP) approach was described in Chapter 6.

In the WTP survey, respondents were asked to choose their willingness to pay amount after considering all the options provided to them in the questionnaire for the probability of reducing risk on a motorcycle accident. Tamin (2000) mentioned that the probability that the individuals choose an option is a function of their socioeconomic characteristics and the relative attractiveness of the options. Moreover, Ben-Akiva and Lerman (1985) stated that the behaviour of an individual coud best be described with discrete variables which can be modelled based on discrete choice analysis.

The results of the questionnaire and their subsequent analysis are explained in detail in this chapter.

7.2 Application of Discrete Choice Methods in Modelling Willingness to Pay Value

Choice methods are applied in this study in order to assess the Willingness to Pay Value.

The utility of selecting a specific WTP choice option *i* can be formulated as follows:

$$U^{n}_{WTP(i)} = V^{n}_{WTP(i)} + \varepsilon^{n}_{WTP(i)} = \beta' X^{n}_{WTP(i)} + \varepsilon^{n}_{WTP(i)} \qquad 7.1$$

Where,

$U^{n}_{WTP(i)}$: = the utility of selecting *WTP(i)* by individual *n.*

$V^{n}_{WTP(i)}$: = the systematic component of utility of selecting *WTP(i)* by individual *n.*

$\varepsilon^{n}_{WTP(i)}$: = the random component of utility.

$X^{n}_{WTP(i)}$ = the vector of attributes that explains the utility of selecting *WTP(i)* by individual *n.*

β' = the vector of unknown parameters.

The choice probability for selecting *WTP(i)* by individual *n* can be written as follows:

$$P^{n}_{WTP(i)} = \frac{e^{\beta' X^{n}_{WTP(i)}}}{\sum_{j \in C^{n}} e^{\beta' X^{n}_{WTP(j)}}} \qquad 7.2$$

Where,

$P^{n}_{WTP(i)}$ = the probability that individual *n* chooses *WTP(i).*

C^{n} = the choice set of the individual *n.*

7.3 Valuing the Case of Slight Casualty to a Motorcyclist

As discussed in Chapter 6, two binary logit models and a multinomial logit model are estimated. For the case of slight casualty, 25% and 50% risk reductions with respective WTP figures IDR 700 and IDR 1,300 are considered. Market segmentation analysis is used for the slight casualty case. This is possible due to the large number of slight accidents in the database which gives a considerable number of samples and enables this study to analyse them for various market segments.

7.3.1 First Binary Model of Slight Casuatly: 25% Risk Reduction (IDR 700)

The hypotheses identified in the previous chapter suggest that income, age and number of children are variables influencing the subjective cost of the severity of an accident and so these were included as determinants of the individual's WTP and tested in the First Binary model of *slight* casualty. The results are shown in Table 7.1. As expected, with the exception of age, all the independent variables show positive correlation with WTP and are significant at the 5% level. The fit of the model to the data is expressed by ρ^2 and this too falls within the expected range of 0 -1. Therefore the logit model which predicts the WTP for a 25% reduction in *slight* casualty to a motorcyclist was found to be:

$$Logit\ (p) = \ln\left(\frac{p}{1-p}\right) = 2.80 - 0.01\ Age + 0.01\ Income + 0.52\ Number\ of\ children$$

Statistical significance is shown by the p-value and is the value at which the decision would switch between accepting or rejection of significance at the 5% level. The critical value for 95% confidence means a p-value must be less than 0.05.

Table 7.1 Results for the First Model for 25% Reduction in Risk of Slight Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 700			
Constant	**2.80**	**0.00**	16.43
Age	**-0.10**	**0.00**	0.91
Income/10,000	**0.01**	**0.00**	1.01
Number of children	**0.52**	**0.02**	1.69
Observations	182		
LL (O)	-97.10		
LL (ρ)	-87.68		
ρ^2	0.10		

Source: This study

This model shows the relationship between the independent variables (in this case age, income/10,000 and the number of children in the family) and the dependent variable, WTP (IDR 700), where the dependent variable is on the logit scale. A positive coefficient is interpreted that, holding everything else constant, a one unit increase in the independent variable would predict the coefficient log odds change in willingness to pay. So, for example, a one unit increase in children in the family would lead to a 0.52 log odds increase in WTP. Negative coefficients have a similar interpretation, but the unit increase in the independent variable in this case leads to a decrease in the dependent variable. Therefore, for example, a one unit increase in age would lead to a 0.10 decrease in the log odds in WTP.

However, because the coefficients are in log odds units, they are difficult to interpret. The odds ratio is shown in the final column of Table 7.1 as exp (β). So for example, for the independent variable of age, the odds ratio of 0.91 means that, holding everything else constant, a one unit increase in age would decrease the odds of being WTP by 0.91.

For the purposes of this study, it is more useful to convert the odds ratio into predictive probability statements. However, this means that different values have to be put into the equation in order to convert the results into a predictive probability statement for individuals with particular characteristics. For these results, the probability of a person being Willing to Pay to reduce the risk by 25% of a *slight* casualty to a motorcyclist can be calculated from the model. If this is a person who is 20 years old with an income of IDR 750,000 and no children, then the probability of this person being willing to reduce the risk of *slight* casualty by 25% is determined by substituting values for age, income and number of children in the equation as follows:

$$Logit\ (p) = \ln\left(\frac{p}{1-p}\right) = 2.80 - 0.01\ \ Age + 0.01\ \ Income + 0.52\ \ Number\ of\ children$$

$$Logit(p) = \ln\left[\frac{p}{1-p}\right] = 2.80 - 0.10\ x\ 20 + 0.01\ x\ (750{,}000/100{,}000) + 0.52\ x\ 0 = 1.76$$

And the probability is therefore:

$$p = \frac{exp^{logit(p)}}{1+\ exp^{logit(p)}} = \frac{exp^{1.76}}{1+\ exp^{1.76}} = 0.85$$

The interpretation of this is that the probability would be 0.85 that a person with the characteristics specified would be Willing to Pay IDR 700 to reduce the risk of a *slight* casualty to a motorcyclist by 25%. Alternatively, 85% of people holding these characteristics would be Willing to Pay IDR 700 to reduce the risk of a *slight* casualty to a motorcyclist by 25%. However, if the respondent is 30 years old with the same income and number of children, the probability that a person with such characteristics would be Willing to Pay IDR 700 to reduce the risk of a *slight* casualty to a motorcyclist by 25% falls to 0.69.

In the sample described in Chapter 6 the maximum number of children in motorcyclists' families is four and most respondents were either 20-29 and 30-39 years old, which is consistent with the majority of motorcyclists who had an accident (presented in Chapter 4). As illustrated in Chapter 4, they are likely to have an income between IDR 500,000 and IDR 1,500,000. Using these results, the probability of age 20-50, income IDR 750,000 – 1,500,000 and number of children 1 – 4 would be as shown in Table 7.2.

Table 7.2 Probability of Willingness to Pay IDR 700 for 25% Reduction in Risk of Slight Casualty to a Motorcyclist

Age (years)	Income (IDR)	Number of Children	Logit p	Exp(β) of the Logit	Probability
20	750,000	0	1.76	5.81	0.85
30	750,000	0	0.80	2.23	0.69
40	750,000	0	-0.15	0.86	0.46
50	750,000	0	-1.11	0.33	0.25
20	750,000	0	1.76	5.81	0.85
20	1,000,000	0	2.05	7.76	0.89
20	1,250,000	0	2.34	10.38	0.91
20	1,500,000	0	2.63	13.88	0.93
20	750,000	1	2.28	9.81	0.91
20	750,000	2	2.81	16.59	0.94
20	750,000	3	3.33	28.03	0.97
20	750,000	4	3.86	47.39	0.98

Source: This study

Table 7.2 shows that as the person becomes older (unshaded values), with everything else held constant, the probability that a person would be willing to pay IDR 700 to reduce the risk of a *slight* casualty to a motorcyclist by 25%, falls. However, for income, holding everything else constant, as the income of the person increases the probability that a person would be Willing to Pay IDR 700 to reduce the risk of a *slight* casualty to a motorcyclist by 25%, increases (lightly shaded values). Moreover, when holding age and income constant, the effect of increased numbers of children in the family means that the probability that a person would be Willing to Pay IDR 700 to reduce the risk of a *slight* casualty to a motorcyclist by 25%, increases (moderately shaded values).

The main conclusion drawn from the analysis is that income and number of children increase the probability that an individual would be Willing to Pay IDR 700 to reduce the risk of a *slight* casualty to a motorcyclist in an accident, but that increasing age decreases this probability. This might be because people with higher income are more aware of reducing the risk and the presence of more children means that they are more conscious of the consequences of an accident. Conversely, the older people are less WTP for lowering the risk and this could be because it is not a case that they are no longer earners, but that they have adult children and possibly place a lower value on their life.

Many studies including TRL (1995) and Silcock and TRL (2003) mentioned that a WTP questionnaire is difficult to use in a developing country because of the necessary complexity of the questionnaire, which is why the education variable was included in the model. The education variable consists of an ordinal variable where 1 represents high school education or lower, 2 represents undergraduate student and 3 graduate and post graduate levels of attainment.

The inclusion of this variable produced an overall slightly better model in terms of fit, based on ρ^2. This can be seen in Table 7.3 that the reliability of fit increased from 0.10 to 0.11 for reducing the risk of a *slight* casualty to a motorcyclist by 25%.

The parameters of income, number of children and age were interpreted as before. The actual sizes of the coefficients are very similar and the signs are the same. In addition, all the coefficients are significantly different from zero at a 5% level of significance.

Table 7.3 Results for the Second Model for 25% Reduction in Risk of Slight Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 700			
Constant	**3.82**	**0.00**	45.56
Age	**-0.10**	**0.00**	0.91
Income/10,000	**0.01**	**0.02**	1.01
Number of children	**0.54**	**0.02**	1.71
Education			
High school and under	-0.85	0.25	0.43
Undergraduate student	-1.02	0.18	0.36
Observations	182		
LL (O)	-97.10		
LL (ρ)	-86.69		
ρ^2	0.11		

Source: This study

The education variables were included in the discrete choice model, effectively being a set of dummy variables, and so the interpretation of the two coefficients, relating to high school and under level of education and for undergraduate student, is relative to the base-line of a person with graduate level education. The coefficients are negative suggesting that, relative to people with a graduate level education, less educated people would be less WTP IDR 700 to reduce the risk of a *slight* casualty to a motorcyclist by 25%. However, these parameters are not significant at a 5% level and so do not lend themselves to statistically valid conclusions. This lack of significance could be partly due to the effect that most of motorcyclists in this study are in the low education group (high school and under) or undergraduate students and only 19% of respondents had obtained graduate level qualification. The relatively small number of graduate level respondents in the sample may bias the result of the model, making the parameters of education non-significant at the 5% level.

7.3.2 Second Binary Model of Slight Casuatly: 50% Risk Reduction (IDR 700)

The model of reducing the risk by 50% of a *slight* casualty to a motorcyclist was also tested, as above, with age, income/10,000 and the number of children in the family. The results are shown in Table 7.4 below. Consistent with the First Binary Model, all the independent variables have the expected signs and are significant at the 5% level and the fit of the model to the data is expressed by ρ^2 and this too falls within the expected range of 0 -1.

The logit model which predicts the willingness to pay for a 50% reduction in *slight* casualty to a motorcyclist was found to be:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 2.89 - 0.10\ Age + 0.01\ Income + 0.54\ Number\ of\ children$$

This model shows the relationship between the independent variables and the dependent variable which is on the logit scale. The logit model of 50% risk reduction in *slight* casualty to a motorcyclist on the binary choices shows that the coefficients of income and number of children have positive signs, while that of age has a negative sign.

Table 7.4 Results for the First Model for 50% in Risk of Slight Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 1,300			
Constant	**2.89**	**0.00**	18.02
Age	**-0.10**	**0.00**	0.91
Income/10,000	**0.01**	**0.00**	1.01
Number of children	**0.54**	**0.01**	1.71
Observations	182		
LL (O)	-100.66		
LL (ρ)	-91.42		
ρ^2	0.09		

Source: This study

For the purpose of this study, the predicted probability that an individual would be WTP IDR 1,300 to reduce the risk by 50% of a *slight* casualty to a motorcyclist, according to this model, will depend upon their age, income/10,000 and the number of children in their family. Using the same example as for in the earlier model (see Section 7.3.1: Binary model – 25% reduction of *slight* casualty to a motorcyclist), that is, a person of 20 years of age with an income of IDR 750,000 and no children, then the probability this person WTP to pay to reduce the risk by 50% of a *slight* casualty to a motorcyclist is as follows:

$$Logit(p) = \ln\left[\frac{p}{1-p}\right] = 2.89 - 0.10\ x\ 20 + 0.01\ x\ (750{,}000/10{,}000) + 0.54\ x\ 0 = 1.68$$

$$p\ =\ \frac{exp^{logit(p)}}{1+\ exp^{logit(p)}}\ =\ \frac{exp^{1.68}}{1+\ exp^{1.68}}\ = 0.84$$

The interpretation of this is that the probability would be 0.84 that a person with these characteristics would be Willing to Pay IDR 1,300 to reduce the risk of a *slight* casualty to a motorcyclist by 50%. This is comparable with 0.85 found for the WTP IDR 700 to reduce the risk of a *slight* casualty by 25%.

Table 7.5 Probability of Willingness to Pay IDR1,300 for 50% Reduction in Risk of Slight Casualty to a Motorcyclist

Age (years)	Income (IDR)	Number of Children	Logit p	Exp(β) of the Logit	Probability
20	750,000	0	1.68	5.35	0.84
30	750,000	0	0.70	2.00	0.67
40	750,000	0	-0.29	0.75	0.43
50	750,000	0	-1.27	0.28	0.22
20	750,000	0	1.68	5.35	0.84
20	1,000,000	0	1.93	6.87	0.87
20	1,250,000	0	2.18	8.83	0.90
20	1,500,000	0	2.43	11.34	0.92
20	750,000	1	2.22	9.16	0.90
20	750,000	2	2.75	15.69	0.94
20	750,000	3	3.29	26.86	0.96
20	750,000	4	3.83	45.99	0.98

Source: This study

As in the interpretation of the First Model, Table 7.5 computes the probabilities for different age, income and number of children scenarios. As before, this demonstrates that increasing age, everything else being held constant, reduces the probability, whereas increasing income, holding everything else constant, increases the probability and increasing the number of children, holding everything else constant, increases the probability that a person would be WTP to reduce the risk by 50% of a *slight* casualty to a motorcyclist.

Table 7.6 The Result of the Second Model for 50% Reduction in Risk of a Slight Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 1,300			
Constant	**3.44**	**0.00**	31.25
Age	**-0.10**	**0.00**	0.90
Income/10,000	**0.01**	**0.01**	1.01
Number of children	**0.54**	**0.01**	1.71
Education			
High school and under	-0.26	0.69	0.77
Undergraduate student	-0.59	0.38	0.56
Observations	182		
LL (O)	-100.66		
LL (ρ)	-90.94		
ρ^2	0.10		

Source: This study

As in the 25% reduction of *slight* casualty model above, in this model also using the three categories for the education variable gives an increase in ρ^2 from 0.09 to 0.1, although the education parameters, as in the earlier model, are not in themselves statistically significant. Table 7.6 shows that the values, signs and significance of theother variables remain the same or are very similar.

7.3.3 Summary of the Binary Model of Slight Casualty

Both the binary logit model results, as discussed above, demonstrate that the WTP for either the 25% risk reduction or the 50% risk reduction of a *slight* casualty to a motorcyclist accident is significantly influenced by:

- **Age**: increasing age, holding everything else constant, decreases the probability that an individual would be WTP either IDR 700 for a 25% risk reduction or IDR 1,300 for a 50% risk reduction of a *slight* casualty to a motorcyclist.
- **Income**: increasing income, holding everything else constant, increases the probability that an individual would be WTP either IDR 700 for a 25% risk reduction or IDR 1,300 for a 50% risk reduction of a *slight* casualty to a motorcyclist.
- **Number of children in the family**: increasing the number of children in a family, holding everything else constant, increases the probability that an individual would be WTP either IDR 700 for a 25% risk reduction or IDR 1,300 for a 50% risk reduction of a *slight* casualty to a motorcyclist.

A comparison of Tables 7.1 and 7.4 clearly shows that both binary models looking at the case of *slight* casualty to a motorcyclist predict similar probabilities for individuals with the same characteristics, with the WTP IDR 700 to reduce risk of *slight* casualty by 25% being marginally higher than for the WTP IDR 1,300 to reduce the risk by 50%.

7.3.4 Market Segmentation Analysis of Slight Casualty with the Binary Models

Investigations focussing on different segments of the sample were carried out to identify whether this explained the choices in more detail. Two particular segmentations appear to give significant statistical results: namely, segmentation by educational achievement and by motorcycle use or not. Tables 7.7 and 7.8, below, show the results for the education sub models. Both models show that statistically significant results are only achieved for the High School and under segment.

Table 7.7 Market Segmentation Sub Model of the Effect of Education on the 25% Reduction in Risk of Slight Causalty to a Motorcyclist

Variable	Education					
	High School and under		*Undergraduate*		*Graduate*	
	Parameter	P-value	Paramete	P-value	Paramete	P-value
Choice IDR 700						
Constant	**3.29**	**0.00**	**3.61**	**0.04**	-3.25	0.54
Age	**-0.12**	**0.00**	-0.13	0.14	0.16	0.39
Income/10,000	**0.01**	**0.06**	0.01	0.24	0.01	0.53
Number of children	**0.69**	**0.02**	0.66	0.29	-0.77	0.44
Observations	89		59		34	
LL (O)	-51.88		-32.33		-10.15	
LL (ρ)	-45.46		-29.68		-9.06	
ρ^2	0.12		0.08		0.11	

Source: This study

Table 7.8 Market Segmentation Sub Model of the effect of Education on the 50% Reduction in Risk of Slight Casualty to a Motorcyclist

Variable	Education					
	High School and		*Undergraduate*		*Graduate*	
	Parameter	P-value	Parameter	P-value	Parameter	P-value
Choice IDR 1300						
Constant	**3.03**	**0.00**	**6.18**	**0.01**	-2.57	0.50
Age	**-0.11**	**0.00**	**-0.25**	**0.03**	0.05	0.67
Income/10,000	**0.01**	**0.07**	0.01	0.13	0.02	0.12
Number of children	**0.58**	**0.04**	1.07	0.11	0.43	0.63
Observations	89		59		34	
LL (O)	-51.88		-28.09		-14.20	
LL (ρ)	-46.55		-33.45		-11.00	
ρ^2	0.10		-0.19		0.23	

Source: This study

Income/10,000 is not statistically significant; however, the other variables are both significant and the parameters are of the same sign and order of magnitude as the basic model.

Table 7.9 Market Segmentation Sub Model for Motorcyclist or Non-Motorcyclist on the 25% Risk in Reduction of Slight Casualty to a Motorcyclist

Variable	Motorcyclist use			
	Motorcyclist		*Non motorcyclist*	
	Parameter	P-value	Parameter	P-value
Choice IDR 700				
Constant	**3.09**	**0.00**	**3.33**	**0.01**
Age	**-0.10**	**0.00**	**-0.11**	**0.05**
Income/10,000	0.01	0.13	0.02	0.07
Number of children	**0.55**	**0.04**	1.19	0.17
Observations	131		51	
LL (O)	-75.01		-20.40	
LL (ρ)	-69.96		-15.17	
ρ^2	0.07		0.26	

Source: This study

Tables 7.9 and 7.10 show the results for the motorcycle user and non-user’s sub models. These reveal that age is statistically significant for all groups and, in both sub-models, the number of children is significant for the motorcyclist user.

Table 7.10 Market Segmentation Sub Model for the Motorcyclist or Non-Motorcyclist 50% Reduction in Risk of Slight Casualty to a Motorcyclist

Variable	Motorcyclist use			
	Motorcyclist		*Non motorcyclist*	
	Parameter	P-value	Parameter	P-value
Choice IDR 1,300				
Constant	**2.97**	**0.00**	3.44	2.86
Age	**-0.10**	**0.00**	-0.10	-2.02
Income/10,000	0.01	0.08	0.01	1.44
Number of children	**0.58**	**0.03**	0.72	1.45
Observations	131		51.0	
LL (O)	-77.03		-22.16	
LL (ρ)	-71.52		-18.37	
ρ^2	0.07		0.17	

Source: This study

Again, for those parameters which are significant, the coefficients are the same sign and magnitude as the basic model as those found for total data set.

7.3.5 Interpretation of the Multinomial Model of Slight Casualty (IDR 1,300; IDR 700; IDR 0)

This first multinomial model considers the respondents' choices between paying nothing and leaving the risk of a motorcycle casualty unaffected or paying IDR 700 or IDR 1,300 to reduce the risk by 25% or 50% respectively of a *slight* casualty following a motorcycle accident. This discussion provides a full description of the results, as it is the first multinomial model considered in this analysis.

Consideration of the results of the multinomial model, provided in Table 7.11, shows the fit of the model to the data expressed by ρ^2 and this too falls within the expected range of 0 -1.

Table 7.11 Result for Multinomial Choice Model for Reduction in Risk of Slight Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Alternative Specific Constants			
Choice IDR 1,300	**3.10**	**0.00**	
Choice IDR 700	1.55	0.10	
Choice IDR 1,300			
Age	**-0.14**	**0.00**	0.87
Income/10,000	**0.02**	**0.00**	1.02
Number of children	**0.70**	**0.01**	2.02
Choice IDR 700			
Age	**-0.11**	**0.01**	0.90
Income/10,000	**0.02**	**0.01**	1.02
Number of children	**0.62**	**0.04**	1.86
Observations	182		
LL (O)	-165.51		
LL (ρ)	-148.26		
ρ^2	0.10		

Source: This study

More importantly, it can be seen from Table 7.11 that the independent variables of age, income/10,000 and the number of children in the household are also significant in distinguishing between the categories of being WTP IDR 700 and WTP IDR 1,300 relative to the baseline of being WTP nothing (IDR 0). In this context, being unwilling to pay (WTP IDR 0) is the baseline case for the analysis.

The logit model which predicts the choice of being willing to pay IDR 1,300 for a 50% risk reduction in *slight* casualty to a motorcyclist versus ignoring the risk reduction and choosing the option of WTP IDR 0 is:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 3.10 - 0.14\ Age + 0.02\ Income + 0.70\ Number\ of\ children$$

and that which predicts the choice of being willing to pay IDR 700 for a 25% risk reduction in *slight* casualty to a motorcyclist versus ignoring the risk reduction and choosing the option of WTP IDR 0 is:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 1.55 - 0.11\ Age + 0.02\ Income + 0.62\ Number\ of\ children$$

As with the interpretation of the coefficients in the binary model, a positive sign of the coefficient means that holding everything else constant, a one unit increase in the independent variable would predict the coefficient log odds change in willingness to pay. For example, taking the coefficient of the number of children in the family in the model, the following interpretations can be made. For making the choice of WTP IDR 1,300 over being WTP IDR 0, one extra child in the family would lead to a 0.70 log odds increase in WTP, while in the case of the choice of WTP IDR 700 over WTP IDR 0, one extra child in the family would lead to a 0.62 log odds increase in WTP. Transferring this to statements using the odds ratio exp(β) in the final column of Table 7.11, this model can be interpreted as, holding everything else constant, an increase in one child in the household means that odds of choosing IDR 1,300 (and the associated risk reduction of 50%) over not paying at all (WTP IDR 0) is 2.02. For the same variable of number of children in the household, but with the comparison of choosing IDR 700 and the associated risk reduction of 25%, an extra child in the family would increase the odds of paying IDR 700 by 1.86. For negative coefficients, movements in the opposite direction are expected.

As with the binary models, it is more useful for this study to be able to consider the probabilities associated with the WTP. Using the same example as in the binary case of an individual who is 20 years old and has an income of IDR 750,000 with no children, then a calculation can be made to predict the probability that this person would be WTP in each of the three categories in this model. This calculation needs to take account of the fact that this multinomial model offers a multiple choice to the respondent and therefore needs to consider three categories, the state of WTP IDR 0, WTP IDR 700 and WTP IDR 1,300.

By substituting the parameters from Table 7.11 into the probability formula, then the probability results for each preference model in turn are as follows:

Preference 1 (IDR 1,300) = $p_1 = e^{3.10 - 0.14\,Age + 0.02\,Income + 0.70\,Number\ of\ children}$

Preference 2 (IDR 700) = $p_2 = e^{1.55 - 0.11 Age + 0.02\,Income + 0.68\,Number\ of\ children}$

Preference 3 (IDR 0) = $p_3 = e^0$

Next, substituting the values of the sample case, which is age = 20 years and income = IDR 750,000, into the model above, the result becomes:

$$p_1 = e^{3.10 - 0.14\,x20 + 0.02\,x(750000/100000) + 0.70\,x0} = e^{1.97} = 7.17$$

$$p_2 = e^{1.55 - 0.11\,x20 + 0.02\,x\,(750000/100000) + 0.68\,x0} = e^{0.63} = 1.87$$

$$p_3 = 1$$

So that the estimated probability that this person would be WTP to reduce their risk in each of the three categories is:

$$p_1 = \frac{7.17}{7.17 + 1.87 + 1} = 0.71$$

$$p_2 = \frac{1.87}{7.17 + 1.87 + 1} = 0.19$$

$$p_3 = \frac{1}{7.17 + 1.87 + 1} = 0.10$$

and $P_1 + P_2 + P_3 = 0.7 + 0.19 + 0.1 = 1$

Since the preference 1 has the highest estimated probability, this multinomial model would predict that the individual under consideration would belong to this model category; i.e. that a person who is 20 years old and has an income of IDR 750,000 with no children would be WTP IDR 1,300 to secure a reduction of 50% in the risk of *slight* casualty from a motorcycle accident.

Predicted probabilities for individuals with different characteristics are tabulated in Table 7.12. Table 7.12 has some interesting features noted as a result of the calculation of predicted probabilities. Interestingly, it is very difficult to find the characteristics of an individual who is predicted to be WTP IDR 700 over paying nothing. This might result from the very low number of respondents that chose this option. The differences in characteristics of individuals appears to make the predicted probability that the individual will either be WTP IDR 1,300 or nothing more likely.

Table 7.12 Probability of Difference Characteristic of a Slight Casualty to a Motorcyclist for Multinomial Model

Age (years)	Income (IDR)	Number of Children	Logit p_1	Exp(β) of p_1	Prob p_1	Logit p2	Exp(β) of p2	Prob p2	Exp(β) of p3	Prob p3
20	750000	0	1.97	7.17	0.71	0.63	1.87	0.19	1.00	0.10
20	1000000	0	2.51	12.32	0.76	1.03	2.80	0.17	1.00	0.06
20	1250000	0	3.05	21.16	0.80	1.43	4.18	0.16	1.00	0.04
20	1500000	0	3.59	36.33	0.83	1.83	6.25	0.14	1.00	0.02
20	750000	1	2.67	14.50	0.76	1.25	3.48	0.18	1.00	0.05
20	750000	2	3.38	29.32	0.80	1.87	6.48	0.18	1.00	0.03
20	750000	3	4.08	59.27	0.82	2.49	12.07	0.17	1.00	0.01
20	750000	4	4.79	119.81	0.84	3.11	22.47	0.16	1.00	0.01
40	750000	0	-0.78	0.46	0.27	-1.50	0.22	0.13	1.00	0.59
40	1000000	0	-0.24	0.79	0.37	-1.10	0.33	0.16	1.00	0.47
40	1250000	0	0.30	1.35	0.47	-0.70	0.50	0.17	1.00	0.35
40	1500000	0	0.84	2.32	0.57	-0.30	0.74	0.18	1.00	0.25
40	750000	1	-0.08	0.93	0.40	-0.88	0.41	0.18	1.00	0.43
40	1000000	2	1.17	3.22	0.60	0.14	1.15	0.21	1.00	0.19
40	1250000	3	2.41	11.17	0.73	1.16	3.20	0.21	1.00	0.07
40	1500000	4	3.66	38.78	0.80	2.19	8.91	0.18	1.00	0.02
50	750000	0	-2.15	0.12	0.10	-2.57	0.08	0.06	1.00	0.84
50	1000000	0	-1.61	0.20	0.15	-2.17	0.11	0.09	1.00	0.76
50	1250000	0	-1.07	0.34	0.23	-1.77	0.17	0.11	1.00	0.66
50	1500000	0	-0.53	0.59	0.32	-1.36	0.26	0.14	1.00	0.54
50	750000	1	-1.45	0.23	0.17	-1.95	0.14	0.10	1.00	0.73
50	750000	2	-0.75	0.47	0.27	-1.33	0.27	0.15	1.00	0.58
50	750000	3	-0.04	0.96	0.39	-0.71	0.49	0.20	1.00	0.41
50	750000	4	0.66	1.94	0.50	-0.08	0.92	0.24	1.00	0.26

Source: This study

At the age of 20, changes in income (over the range IDR 750,000 to IDR 1,500,000) or changes in the number of the children in the household (from 0 – 4) do not change the probability that such an individual will be in the group that chooses WTP IDR 1,300 over WTP IDR 0. At the age of 40, the predicted probability suggests that an individual will switch, if there are no children in the household, when income rises above IDR 1,250,000 from WTP nothing to WTP IDR 1,300. At the age of 40, if one child is in the household, the switch takes place at below the income of IDR 1,000,000. For more than one child, a person at the age of 40 always chooses WTP IDR 1,300 over WTP IDR 0. At the age of 50, the switch takes place at the point where the number of children is less than 4.

Table 7.13 The Result of the Second Model for Risk Reduction of a Slight Casualty to Motorcyclists (Multinomial Choices)

Variable	Parameter	P-value	Exp (β)
Alternative Specific Constants			
Choice IDR 1,300	**23.25**	**0.00**	
Choice IDR 700	**21.49**	**0.00**	
Choice IDR 1,300			
Age	**-0.13**	**0.00**	0.87
Income	**0.02**	**0.01**	1.02
Number of children	**0.82**	**0.00**	2.28
Education			
High school and under	**-20.42**	**0.00**	0.00
Undergraduate student	**-19.86**	**0.00**	0.00
Choice IDR 700			
Age	**-0.14**	**0.00**	0.87
Income	**0.02**	**0.01**	1.02
Number of children	0.60	0.06	1.82
Education			
High school and under	**-18.70**	**0.00**	0.00
Undergraduate student	-20.67		0.00
Observations	182		
LL (O)	-166.90		
LL (ρ)	-134.52		
ρ^2	0.19		

Source: This study

As with the binary models, the multinomial model shows a better fit when the education variable is included with age, income/10,000 and number of children (Table 7.13). Again these results demonstrate an overall significant relationship which is 0.10 into 0.19 (statistically significantly different from zero with a p-value of 0.00).

The additional information offered by this model is that the educational status is statistically significant in the WTP decision. The impact of this variable is as would be expected, with lower attainment in education being associated with lower WTP, as compared to those who have received graduate education. However, whilst statistically significant, the odds ratio is very small (zero) which leads to the conclusion that there is no predictive value from this variable in relation to the choice of WTP IDR 1,300 or IDR 700 over paying nothing.

7.3.6 Summary of the Multinomial Model of Slight Casualty

The multinomial model results discussed above support the findings identified in the binary models in relation to age, income/10,000 and number of children in the family. In terms of prediction, this model is more useful because the predicted probabilities highlight some interesting features such as an individual of age 40 will switch between being WTP IDR 1,300 and WTP IDR 0 at certain income levels, namely IDR 125,000 and IDR 150,000 when there is more than one child in the household and also at the age of 50. Therefore, the Multinomial Model gives more insight into the potential behavioural response to a WTP discussion over the binary models when the choice is to pay something or to pay nothing.

7.4 Valuing the Case of Serious with no Disability Casualty to Motorcyclists

This section presents, for each Model Scenario in turn, an interpretation of the results for the serious with no disability to motorcyclist.

7.4.1 First Binary Model of Serious with no Disability Casualty: 25% Risk Reduction (IDR 2,500)

One of the objectives of this study was to identify the contribution of income, age and number of children on the WTP value of the casualties and so these are included as determinants of the individuals' willingness to pay, and tested for statistical significance in the model. The results are shown in Table 7.14.

Table 7.14 Result for The First Model for 25% Reduction in Risk of Serious with no Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 2,500			
Constant	**3.13**	**0.00**	22.83
Age	**-0.11**	**0.00**	0.90
Income/10,000	**0.02**	**0.00**	1.02
Number of children	0.41	0.06	1.51
Observations	182		
LL (O)	-89.10		
LL (ρ)	-77.35		
ρ^2	0.13		

Source: This study

All the independent variables (income, age and number of children) have the expected signs and are statistically significant at the 5% level, except number of children, which is statistically significant at the 10% level. The goodness of fit of the model to the data expressed by ρ^2 falls within the expected range of 0 -1**.**

The logit model predicting the willingness to pay for a 25% reduction in risk of *serious with no disability* to a motorcyclist is:

$$Logit\ (p) = \ln\left(\frac{p}{1-p}\right) = 3.13 - 0.11\ Age + 0.02\ Income + 0.41\ Number\ of\ children$$

This model shows the relationship between the independent variables (in this case, age, income/10,000 and the number of children in the family) and the dependent variable, willingness to pay, where the dependent variable is on the logit scale. The logit model of *serious with no disability* to a motorcyclist on the first binary choices has shown that the coefficients of the income/10,000 and numbers of children have positive signs, while the coefficient for age has a negative sign.

According to this model, the predicted probability that an individual would be willing to pay to reduce the risk by 25% of a *serious with no disability* to a motorcyclist will depend on their age, income/10,000 and the number of children in their family. Using the case shown in the earlier model (refer to Binary model of *slight* casualty in Section 7.3.1), given a person who is 20 years old and has an income of IDR 750,000 and no children, then the probability this person would be willing to pay to reduce the risk by 25% of a *serious with no disability* to a motorcyclist is achieved by substituting values for age, income/10,000 and number of children into the equation to give:

$$Logit(p) = \ln\left[\frac{p}{1-p}\right] = 3.13 - 0.11\ x\ 20 + 0.02\ x\ (750{,}000/10{,}000) + 0.41\ x\ 0 = 2.22$$

the probability is therefore:

$$p = \frac{exp^{logit(p)}}{1 + exp^{logit(p)}} = \frac{exp^{2.22}}{1 + exp^{2.22}} = 0.90$$

The interpretation of this is that the probability would be 0.90 that a person with these characteristics would be willing to pay IDR 2,500 to reduce the risk of a *serious with no disability* casualty to a motorcyclist by 25%. Alternatively, 90% of people with these characteristics would be willing to pay IDR 2,500 to reduce the risk of a *serious with no disability* casualty to a motorcyclist by 25%. However, if the respondent is 30 years old with the same income and number of children, the probability of that person with these characteristics being willing to pay IDR 2,500 to reduce the risk of a *serious with no disability* motorcyclist casualty by 25% is 0.76.

Table 7.14 shows that with rising age and everything else held constant, the probability that a person would be willing to pay IDR 2,500 to reduce the risk of a *serious with no permanent disability* to the motorcyclist by 25% drops. For income, holding everything else constant, as the income of the person increases the probability that a person would be willing to pay IDR 2,500 to reduce the risk of a *serious with no disability* to the motorcyclist by 25%, increases. Moreover, when holding age and income/10,000 constant, the effect of children in the family means that the probability that a person would be willing to pay IDR 2,500 to reduce the risk of a *serious with no disability* casualty to the motorcyclist by 25% also increases.

Similar to the *slight* casualty results, the results in Table 7.15 show that income/10,000 and number of children increase the probability that an individual is willing to pay IDR 2,500 to reduce the risk of a *serious with no disability* casualty to a motorcyclist by 25% increase, but that increasing age decreases this probability.

Table 7.15 Probability of Willingness to Pay IDR 2,500 for 25% Reduction in Risk of Serious with no Disability Casualty to Motorcyclists

Age (years)	Income (IDR)	Number of Children	Logit p	Exp(β) of the logit	Probability
20	750,000	0	2.22	9.24	0.90
30	750,000	0	1.15	3.15	0.76
40	750,000	0	0.07	1.07	0.52
50	750,000	0	-1.00	0.37	0.27
20	1,000,000	0	2.64	14.00	0.93
20	1,250,000	0	3.05	21.21	0.95
20	1,500,000	0	3.47	32.14	0.97
20	750,000	1	2.63	13.94	0.93
20	750,000	2	3.05	21.02	0.95
20	750,000	3	3.46	31.72	0.97
20	750,000	4	3.87	47.85	0.98

Source: This study

The education variable has also been added to this model. The education variable consists of an ordinal variable where 1 represents high school education or lower, 2 represents undergraduate student and 3 graduate levels of attainment. The inclusion of this variable produced an overall better model in terms of fit, based on ρ^2. It can be seen in Table 7.16 that the goodness of fit increased from 0.13 into 0.16 for reducing the risk of a *serious with no disability* casualty to the motorcyclist by 25%.

The parameters of income/10,000, number of children and age are to be interpreted as before. The actual sizes of the coefficients are very similar and the signs are the same. In addition, all the coefficients including the number of children are significantly different from zero at a 5% level of statistical significance. The education variable is effectively a set of dummy variables and so the interpretation of the two coefficients, relating to high school and under level of education and for undergraduates are relative to the base-line of a person with graduate level education. The coefficients are negative suggesting that, relative to people with a graduate level of education, less educated people would be less willing to pay IDR 2,500 to reduce the risk of a *serious with no disability* casualty to the motorcyclist by 25%. Unfortunately, these parameters are not significant at a 5% level and so no valid conclusions may be drawn.

Table 7.16 Result for the Second Model for 25% Reduction in Risk of Serious with no Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 2,500			
Constant	**4.70**	**0.00**	109.94
Age	**-0.10**	**0.00**	0.91
Income/10,000	**0.01**	**0.01**	1.01
Number of children	**0.45**	**0.05**	1.57
Education			
High school and under	-1.88	0.09	0.15
Undergraduate student	-1.44	0.21	0.24
Observations	182		
LL (O)	-89.10		
LL (ρ)	-75.14		
ρ^2	0.16		

Source: This study

This might be because most motorcyclists in the population as a whole are in the lower education group (high school and under) and undergraduate students, with only 19% of respondents in the graduate level. The small percentage of those educated to graduate level in the sample means that a higher sample (than 182) would be required to achieve statistical significance at the 5% level.

7.4.2 Second Binary Model of Serious with no Disability Casualty: 50% Risk Reduction (IDR 4,200)

The model of reducing the risk by 50% for a *serious with no disability* casualty to the motorcyclist was also tested with age, income/10,000 and the number of children in the family. The results are shown in Table 7.17 below. The independent variables of income/10,000 and age display the expected signs and are statistically significant at the 5% level, whereas the number of children is statistically significant at the 10% level. The fit of the model to the data is expressed by ρ^2 and this too falls within the expected range of 0 -1.

The logit model of 50% risk reduction of *serious with no disability* casualty to a motorcyclist on the binary choices is:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 1.17 - 0.07\ Age + 0.01\ Income + 0.34\ Number\ of\ \ children$$

Table 7.17 Results for the Second Model for 50% Reduction in Risk of Serious with no Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 4,200			
Constant	1.17	0.06	3.21
Age	**-0.07**	**0.01**	0.93
Income/10,000	**0.01**	**0.00**	1.01
Number of children	0.34	0.07	1.40
Observations	182		
LL (O)	-120.78		
LL (ρ)	-107.72		
ρ^2	0.11		

Source: This study

This model shows the relationship between the independent variables and the dependent variable, where the dependent variable is on the logit scale. The logit model of 50% risk reduction in *serious with no disability* casualty to a motorcyclist in the binary choices has shown that the coefficients of the income/10,000 and numbers of children have positive signs, while the age has a negative sign. Therefore, the predicted probability that an individual would be willing to pay to reduce the risk by 50% of a *serious with no disability* casualty to a motorcyclist, according to this model, will depend on their age, income/10,000 and the number of children in their family. Using the same case as in the *slight* casualty model, given a person who is 20 years old with an income of IDR 750,000 and no children, then the probability this person would be willing to pay to reduce the risk by 50% of a *serious with no disability* casualty to a motorcyclist is:

$$Logit(p) = \ln\left[\frac{p}{1-p}\right] = 1.17 - 0.07\ x\ 20 + 0.01\ x\ (750{,}000/10{,}000) + 0.34\ x\ 0 = 0.84$$

$$p = \frac{exp^{logit(p)}}{1 + exp^{logit(p)}} = \frac{exp^{0.84}}{1 + exp^{0.84}} = 0.70$$

The interpretation of this is that the probability would be 0.70 that a person with these characteristics would be willing to pay IDR 4,200 to reduce the risk of a *serious with no disability* casualty to a motorcyclist by 50%.

Table 7.18 Probability of Willingness to Pay IDR 4,200 for 50% Reduction in Risk of Serious with no Disability Casualty to a Motorcyclist

Age (years)	Income (IDR)	Number of Children	Logit p	Exp(β) of the logit	Probability
20	750,000	0	0.84	2.31	0.70
30	750,000	0	0.12	1.12	0.53
40	750,000	0	-0.61	0.55	0.35
50	750,000	0	-1.33	0.26	0.21
20	1,000,000	0	1.21	3.35	0.77
20	1,250,000	0	1.58	4.85	0.83
20	1,500,000	0	1.95	7.04	0.88
20	750,000	1	1.18	3.24	0.76
20	750,000	2	1.51	4.55	0.82
20	750,000	3	1.85	6.38	0.86
20	750,000	4	2.19	8.96	0.90

Source: This study

As in the interpretation of the previous model (see above), Table 7.18 presents the probabilities for different age, income/10,000 and number of children scenarios. As before, this shows that increasing age, everything else being held constant, reduces the probability, whereas increasing income, holding everything else constant, decreases the probability and increasing the number of children, holding everything else constant, increases the probability that a person would be willing to pay to reduce the risk by 50% of a *serious with no disability* casualty to a motorcyclist. These trends are consistent with other scenarios.

As before, using the three category version of the education variable gives an increase in ρ^2 from 0.11 to 0.13, although the education parameters are not in themselves significant. This is shown in Table 7.19, where it can be seen that the values, signs and statistical significance of the other variables have remained the same or very similar to the first model.

Table 7.19 Result for the Second Model for 50% Reduction in Risk of Serious with no Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 4,200			
Constant	1.67	0.06	5.29
Age	**-0.06**	**0.02**	0.94
Income/10,000	**0.01**	**0.00**	1.01
Number of children	**0.39**	**0.04**	1.48
Education			
High school and under	-1.02	0.10	0.36
Undergraduate student	-0.34	0.60	0.71
Observations	182		
LL (O)	-120.78		
LL (ρ)	-105.36		
ρ^2	0.13		

Source: This study

7.4.3 Summary of the Binary Models of Serious Casualty with no Disability

Both the binary logit model results discussed above demonstrate that the amount of willingness to pay for either the 25% risk reduction or the 50% risk reduction of a *serious with no disability* casualty to the motorcyclist is significantly affected by:

- Age: increasing age, holding everything else constant, decreases the probability that an individual would be willing to pay either IDR 2,500 for a 25% risk reduction or IDR 4,200 for a 50% risk reduction in *serious with no disability* casualty to the motorcyclist.
- Income: increasing income, holding everything else constant, increases the probability that an individual would be willing to pay either IDR 2,500 for a 25% risk reduction or IDR 4,200 for a 50% risk reduction in *serious with no disability* casualty to the motorcyclist.
- Number of children in the family, holding everything else constant, increases the probability that an individual would be willing to pay either IDR 2,500 for a 25% risk reduction or IDR 4,200 for a 50% risk reduction in *serious with no disability* casualty to the motorcyclist.
- Both binary models looking at *serious with no disability* casualty to the motorcyclist predict similar patterns of probabilities for individuals with the same characteristics (a comparison of Table 7.14 and Table 7.17); however, the probability of people choosing the 25% reduction is higher than the 50% reduction.

7.4.4 Interpretation of the Multinomial Model of Serious with no Disability Casualty (IDR 4,200; IDR 2,500: IDR 0)

This multinomial model of *serious with no disability* casualty to a motorcyclist considers the respondents' choices between paying IDR 2,500 or IDR 4,200 to reduce the risk by 25% or 50% respectively of the casualty as a result of a motorcycle accident relative to paying nothing (unwilling to pay). In this context, being unwilling to pay (WTP IDR 0) is the baseline case for the analysis.

The model shows that a statistically significant relationship exists, overall, between the dependent variable of the WTP choices and the independent variables included in the model; however, the number of children in the household has a statistically insignificant result especially for WTP IDR 4,200 (Table 7.20).

Table 7.20 Result for the Multiple Choice Model for Reduction in Risk of Serious with no Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Alternative Specific Constants			
Choice IDR 4,200	**3.47**	**0.00**	
Choice IDR 2,500	**2.56**	**0.00**	
Choice IDR 4,200			
Age	**-0.15**	**0.00**	0.86
Income/10,000	**0.03**	**0.00**	1.03
Number of children	0.44	0.08	1.56
Choice IDR 2,500			
Age	**-0.11**	**0.00**	0.90
Income/10,000	**0.02**	**0.00**	1.02
Number of children	0.33	0.19	1.39
Observations	182		
LL (O)	-175.55		
LL (ρ)	-156.15		
ρ^2	0.11		

Source: This study

The logit model which predicts a choice of being willing to pay IDR 4,200 for a 50% risk reduction of a *serious with no disability* casualty to a motorcyclist versus ignoring the risk reduction and choosing the option of WTP IDR 0 is:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 3.47 - 0.15\ Age + 0.03\ Income + 0.44\ Number\ of\ children$$

which predicts a choice of being willing to pay IDR 2,500 for a 25% risk reduction in a *serious with no disability* casualty to a motorcyclist versus ignoring the risk reduction and choosing the option of WTP IDR 0, which is:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 2.56 - 0.11\ Age + 0.02\ Income + 0.33\ Number\ of\ children$$

For a positive coefficient, the interpretation would be that, holding everything else constant, a one unit increase in the independent variable would predict the coefficient log odds increase in willingness to pay, while for negative coefficients, movements in the opposite direction are expected. As with the previous models, it is more useful as far as this study is concerned to be able to consider the probabilities associated with the WTP. Using the same example as in the binary case of an individual who is 20 years old with an income of IDR 750,000 and no children, then a calculation can be made to predict the probability that this person would be WTP in each of the three categories in this model. This calculation needs to take account of the fact that this multinomial model offers a multiple choice to the respondent and therefore needs to consider three categories, WTP IDR 0, WTP IDR 2,500 and WTP IDR 4,200.

Similar to the analysis process in the *slight* casualty case, firstly substitute parameters in Table 7.20 into the probability formula, then the probability results for each preferences model are as follow:

Preference 1 (IDR 4,200) = $p_1 = e^{3,47 - 0.15\,Age + 0.03\,Income + 0.44\,Number\ of\ children}$

Preference 2 (IDR 2,500) = $p_2 = e^{2.56 - 0.11 Age + 0.02\,Income + 0.33\,Number\ of\ children}$

Preference 3 (IDR 0) = $p_3 = e^0$

Next, substituting the values of the sample case, which is age = 20 years and income = IDR 750,000, into the model above, the result would be:

$$p_1 = e^{3.47 - 0.15\,x20 + 0.03\,x(750000/100000) + 0.44\,x0} = e^{2.40} = 11.00$$

$$p_2 = e^{2.56 - 0.11\,x20 + 0.02\,x\,(750000/100000) + 0.33\,x0} = e^{1.71} = 5.53$$

$$p_3 = 1$$

So that the estimated probability of this person's willingness to pay to reduce risk in each of the three categories is:

$$p_1 = \frac{11}{11 + 5.53 + 1} = 0.63$$

$$p_2 = \frac{5.53}{11 + 5.53 + 1} = 0.32$$

$$p_3 = \frac{1}{11 + 5.53 + 1} = 0.06$$

Since preference 1 has the highest estimated probability, this multinomial model would predict that the individual under consideration would belong to this model category; i.e. a person who is 20 years old and has an income of IDR 750,000 with no children would be WTP IDR 4,200.

Predicted probabilities for individuals with different characteristics are tabulated in Table 7.21. This table emphasises the interesting cases noted as a result of the calculation of predicted probabilities. Similar to the multinomial model of *slight* casualty, it is very difficult to find the characteristics of an individual who is predicted to be WTP IDR 2,500 over paying nothing. This may be because very few respondents chose this option in the questionnaire. Differences in characteristics appear to make the predicted probability more likely to be that the individual will either be WTP IDR 4,200 or nothing.

Table 7.21 Probabilities of Different Characteristics of Serious with no Disabilitiy Casualty to a Motorcyclist

Age (years)	Income (IDR)	Number of Children	Logit p_1	Exp(β) of p_1	Prob p_1	Logit p_2	Exp(β) of p_2	Prob p_2	Exp(β) of p_3	Prob p_3
20	750000	0	2.40	11.00	0.63	1.71	5.53	0.32	1.00	0.06
20	1000000	0	3.04	20.95	0.68	2.16	8.65	0.28	1.00	0.03
20	1250000	0	3.69	39.87	0.73	2.60	13.52	0.25	1.00	0.02
20	1500000	0	4.33	75.88	0.77	3.05	21.14	0.22	1.00	0.01
20	750000	1	2.84	17.13	0.66	2.04	7.72	0.30	1.00	0.04
20	750000	2	3.28	26.67	0.69	2.38	10.76	0.28	1.00	0.03
20	750000	3	3.73	41.52	0.72	2.71	15.00	0.26	1.00	0.02
20	750000	4	4.17	64.64	0.75	3.04	20.91	0.24	1.00	0.01
40	750000	0	-0.60	0.55	0.25	-0.47	0.62	0.29	1.00	0.46
40	1000000	0	0.04	1.04	0.35	-0.03	0.97	0.32	1.00	0.33
40	1250000	0	0.69	1.98	0.44	0.42	1.52	0.34	1.00	0.22
40	1500000	0	1.33	3.78	0.53	0.87	2.38	0.33	1.00	0.14
40	750000	1	-0.16	0.85	0.31	-0.14	0.87	0.32	1.00	0.37
40	1000000	2	0.93	2.53	0.47	0.64	1.89	0.35	1.00	0.18
40	1250000	3	2.01	7.49	0.59	1.42	4.12	0.33	1.00	0.08
40	1500000	4	3.10	22.18	0.69	2.19	8.98	0.28	1.00	0.03
50	750000	0	-2.10	0.12	0.09	-1.57	0.21	0.16	1.00	0.75
50	1000000	0	-1.46	0.23	0.15	-1.12	0.33	0.21	1.00	0.64
50	1250000	0	-0.81	0.44	0.23	-0.67	0.51	0.26	1.00	0.51
50	1500000	0	-0.17	0.84	0.32	-0.23	0.80	0.30	1.00	0.38
50	750000	1	-1.66	0.19	0.13	-1.24	0.29	0.20	1.00	0.68
50	750000	2	-1.22	0.30	0.17	-0.90	0.41	0.24	1.00	0.59
50	750000	3	-0.77	0.46	0.23	-0.57	0.57	0.28	1.00	0.49
50	750000	4	-0.33	0.72	0.29	-0.24	0.79	0.31	1.00	0.40

Source: This study

Table 7.21 shown that at the age of 20, changes in income (over the range IDR 750,000 to IDR 1,500,000) or changes in the number of children in the household (from 0 – 4) do not change the probability that such an individual will shift into the group that chooses WTP IDR 2,500. At the age of 40, the predicted probability suggests that an individual will switch, if the income is IDR 750,000. Unlike at the age of 20, at the age of 50 the switch takes place at all incomes (IDR 750,000 – IDR 1,500,000) or changes in the number of the children in the household (0 – 4). This result, overall, has exposed a threshold effect of WTP value between IDR 2,500 and IDR 4,500 and clearly indicates that disposable income is a key driver in influencing the WTP. However, age and number of children appear to have a greater influence over income in shifting the probabilities into a higher WTP group.

As with the binary models, the multinomial model shows a better fit when the education variable is included with age, income/10,000 and the number of children (Table 7.22). Again these results demonstrate an overall statistically significant relationship with a change from 0.11 to 0.16 (statistically significantly different from zero with a p-value of 0.00).

The additional information offered by this model is that the educational status is statistically significant in WTP decisions. The impact of this variable is as expected with a lower attainment in education being associated with WTP being less, as compared to those with a graduate education. However, whilst statistically significant, the odds ratio that there is no predictive value from this variable in relation to the choice of WTP IDR 4,200 or IDR 2,500 over paying nothing is very small (zero).

Table 7.22 Result for the Second Multiple Choice Model for Reduction in Risk for Serious with no Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Alternative Specific Constant			
Choice IDR 4,200	**22.49**	**0.00**	
Choice IDR 2,500	**21.99**	**0.00**	
Choice IDR 4,200			
Age	**-0.15**	**0.00**	0.86
Income/10,000	**0.02**	**0.00**	1.02
Number of children	0.49	0.07	1.63
Education			
High school and under	**-19.05**	**0.00**	0.00
Undergraduate student	**-18.88**	**0.00**	0.00
Choice IDR 2,500			
Age	**-0.14**	**0.00**	0.87
Income/10,000	**0.02**	**0.01**	1.02
Number of children	0.30	0.26	1.36
Education			
High school and under	**-18.26**	**0.00**	0.00
Undergraduate student	-19.65	.	0.00
Observations	182		
LL (O)	-178.03		
LL (ρ)	-148.97		
ρ^2	0.16		

Source: This study

7.4.5 Summary of the Multinomial Model of Serious with no Disability Casualty to a Motorcyclist

The multinomial model results discussed above support the findings identified in the binary models in relation to age, income/10,000 and number of children in the family. In terms of prediction, this model is more useful as calculating predicted probabilities highlights some interesting features such as an individual of age 40 will switch between being WTP IDR 4,200 and WTP IDR 0 at certain incomes and this gives more insight into the potential behavioural response to a WTP discussion over the binary models where the choice was to pay something or to pay nothing.

7.5 Valuing the Case of Serious with Disability Casualty to a Motorcyclist

This section presents for each Model Scenario in turn, an interpretation of the results for the serious with disability casualty to a motorcyclist.

7.5.1 First Binary Model of Serious with Disability Casualty: 25% Risk Reduction (IDR 3,000)

Similar to previous models, income/10,000, age and number of children are variables included as determinants of the individual's willingness to pay and tested in the model. The results are shown in Table 7.23 below.

Table 7.23 Results for the First Model for 25% Reduction in Risk of Serious with Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 3,000			
Constant	**2.81**	**0.00**	16.67
Age	**-0.10**	**0.00**	0.90
Income/10,000	**0.02**	**0.00**	1.02
Number of children	0.33	0.12	1.39
Observations	182		
LL (O)	-89.10		
LL (ρ)	-75.76		
ρ^2	0.15		

Source: This study

Age and income/10,000 as the independent variables have the expected signs and are statistically significant at the 5% level or at least at the 10% level; however, the number of children variable is not statistically significant at the 5% level or even at the 10% level. The goodness fit of the model to the data as expressed by ρ^2 also falls within the expected range of 0 -1, consistent with other scenarios presented above.

The logit model which predicts the willingness to pay for a 25% reduction in the risk of *serious with disability* casualty to a motorcyclist is:

$$Logit\left(p\right)=\ln\left(\frac{p}{1-p}\right)=2.81-0.01\ \ Age+0.02\ \ Income+0.33\ \ Number\,of\ \ children$$

This model shows the relationship between the independent variables (in this case age, income/10,000 and the number of children in the family) and the dependent variable, willingness to pay, where the dependent variable is on the logit scale. It shows in the model that age and income/10,000 are statistically significant at the 5% level, but the number of children in the family is only statistically significant at the 90% level of confidence, a result that is inconsistent with model scenarios presented earlier. According to this model, the predicted probability that an individual would be willing to pay to reduce the risk by 25% of a *serious with disability* casualty to a motorcyclist will depend on their age and income/10,000, but not the number of children in their family at 95% statistical level of confidence. Using the case shown in the earlier models, given a person 20 years old with an income of IDR 750,000 and with no children, then the probability that this person would be willing to pay to reduce the risk by 25% of a *serious with disability* casualty is, substituting values for age, income/10,000 and number of children in the equation. By using the example with no children, the result is not affected by the lower statistical significance of the number of children, but the lower variable.

$$Logit(p) = \ln\left[\frac{p}{1-p}\right] = 2.81 - 0.10\ x\ 20 + 0.02\ x\ (750{,}000/10{,}000) + 0.33\ x\ 0 = 2.29$$

The probability is therefore:

$$p = \frac{exp^{logit(p)}}{1+ exp^{logit(p)}} = \frac{exp^{2.29}}{1+ exp^{2.29}} = 0.91$$

The interpretation of this is that the probability would be 0.91 that a person with these characteristics would be willing to pay IDR 3,000 to reduce the risk by 25% of a *serious with disability* casualty to a motorcyclist.

The lack of statistical significance at the 95% level for the independent variable number of children raises some important issues. On the one hand, it could reflect the inadequacy of the sample in this study or, on the other hand, it could be due to under representation of that sector (individuals with children, 1, 2, 3, 4) in the particular sample collected. Given that the analysis of *serious with no disability*, with statistically significant confidence at the 95% level, highlighted the relevance of the number of children in the family, here, the interpretation of the data continues with the number of children as an independent variable within the logit model, acknowledging the lower level of statistical confidence of the conclusion drawn.

Similar to the *slight* motorcyclist casualty case, the results show in Table 7.24 that income/10,000 and number of children at the 90% level of confidence increases the probability that an individual would be willing to pay IDR 3,000 to reduce the risk of a *serious with disability* casualty to a motorcyclist, but that increasing age decreases at 95% statistical confidence in this probability.

Table 7.24 Probability of Willingness to Pay IDR 3,000 for 25% Reduction in Risk of Serious with Disability Casualty to a Motorcyclist

Age (years)	Income (IDR)	Number of Children	Logit p	Exp(β) of the logit	Probability
20	750,000	0	2.29	9.87	0.91
30	750,000	0	1.25	3.51	0.78
40	750,000	0	0.22	1.24	0.55
50	750,000	0	-0.82	0.44	0.31
20	1,000,000	0	2.81	16.54	0.94
20	1,250,000	0	3.32	27.71	0.97
20	1,500,000	0	3.84	46.41	0.98
20	750,000	1	2.62	13.77	0.93
20	750,000	2	2.95	19.19	0.95
20	750,000	3	3.29	26.76	0.96
20	750,000	4	3.62	37.30	0.97

Source: This study

The education variable has again been added to the previous model. The inclusion of this variable produced an overall better model in terms of fit, based on the value of ρ^2. It can be seen in Table 7.25 that the goodness of fit increased from 0.15 to 0.16 for WTP IDR 3,000 for reducing the risk by 25% of a *serious with disability* casualty to a motorcyclist.

Table 7.25 Results of the Second Model for a 25% Reduction in Risk of a Serious with Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 3,000			
Constant	**4.25**	**0.00**	70.08
Age	**-0.10**	**0.00**	0.91
Income/10,000	**0.02**	**0.00**	1.02
Number of children	0.35	0.11	1.42
Education			
High school and under	-1.56	0.16	0.21
Undergraduate student	-1.36	0.25	0.26
Observations	182		
LL (O)	-89.10		
LL (ρ)	-74.47		
ρ^2	0.16		

Source: This study

The parameters of income/10,000, number of children and age are interpreted as before. The actual sizes of the coefficients are very similar and the signs are the same. In addition, similar to the previous model where education had not been included, the age and income/10,000 are significantly different from zero at a 5% level of significance, while the number of children is not statistically significant at 95%, but at slightly less than 90% level of confidence. The education variable is effectively a set of dummy variables and so the interpretation of the two coefficients, relating to high school and under level of education and for undergraduates is relative to the base-line of a person with graduate level education. The coefficients are negative, suggesting that, relative to people with a graduate level of education, less educated people would be less willing to pay IDR 3,000 to reduce by 25% the risk of a *serious with disability* casualty to a motorcyclist. However, these parameters are not statistically significant at a 5% level and so no valid conclusions may be drawn leading to conclusions for earlier modelled scenarios.

7.5.2 Second Binary Model of Serious with Disability Casualty: 50% Risk Reduction (IDR 5,900)

The model of reducing the risk by 50% of a *serious with disability* casualty to a motorcyclist was also tested with age, income/10,000 and the number of children in the family. The results are shown in Table 7.26 below. The independent variables of income/10,000 and age have the expected signs and are statistically significant at 5% level, whereas the number of children is not statistically significant. The fit of the model to the data is expressed by ρ^2 and this too falls within the expected range of 0 -1, endorsing the dependability of the model fitting to the data.

Table 7.26 Results of the First Model for 50% Reduction in Risk of a Serious with Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 5,900			
Constant	1.15	0.07	3.16
Age	**-0.08**	**0.00**	0.93
Income/10,000	**0.02**	**0.00**	1.02
Number of children	0.07	0.71	1.07
Observations	182		
LL (O)	-116.75		
LL (ρ)	-96.85		
ρ^2	0.17		

Source: This study

The logit model of a 50% reduction in risk of a *serious with disability* casuality to a motorcyclist on the binary choices is:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 1.15 - 0.08\ Age + 0.02\ Income + 0.07\ Number\ of\ children$$

For the purpose of this study, the predicted probability that an individual would be willing to pay to reduce the risk by 50% of a *serious with disability* casualty to a motorcyclist, according to this model, will depend on their age, income/10,000 and, including the number of children in their family, will realise the statistical confidence of the predictor to 90%. As in the previous models, using the case of a person who is 20 years old with an income of IDR 750,000 and no children, then the probability this person would be willing to pay to reduce the risk by 50% of a *serious with disability* casualty to a motorcyclist is calculated by substituting values into the equation. By using an example with no children, the result is not affected by the lower statistical significance of the number of children variable.

$$Logit(p) = \ln\left[\frac{p}{1-p}\right] = 1.15 - 0.08\ x\ 20 + 0.02\ x\ (750{,}000/10{,}000) + 0.07\ x\ 0 = 1.36$$

$$p = \frac{exp^{logit(p)}}{1 + exp^{logit(p)}} = \frac{exp^{1.36}}{1 + exp^{1.36}} = 0.80$$

The interpretation of this is that the probability would be 0.80 that a person with these characteristics would be willing to pay IDR 5,900 to reduce the risk by 50% of a *serious with disability* casualty to a motorcyclist .

Table 7.27 Probability of Willingness to Pay IDR 5,900 for 50% Reduction in Risk of a Serious with Disability Casualty to a Motorcyclist

Age (years)	Income (IDR)	Number of	Logit p	Exp(β) of the logit	Probability
20	750,000	0	1.36	3.88	0.80
30	750,000	0	0.58	1.78	0.64
40	750,000	0	-0.20	0.82	0.45
50	750,000	0	-0.97	0.38	0.27
20	1,000,000	0	1.94	6.97	0.87
20	1,250,000	0	2.53	12.52	0.93
20	1,500,000	0	3.11	22.49	0.96
20	750,000	1	1.42	4.15	0.81
20	750,000	2	1.49	4.45	0.82
20	750,000	3	1.56	4.76	0.83
20	750,000	4	1.63	5.10	0.84

Source: This study

As in the interpretation of the logit model of a 50% risk reduction in *serious with disability* casualty to a motorcyclist on the binary choices, Table 7.27 presents the computed probabilities for different age, income/10,000 and number of children scenarios. As before, this shows that increasing age, everything else being held constant, reduces the probability, whereas increasing income, holding everything else constant, increases the probability that a person would be willing to pay to reduce the risk by 50% of a *serious with disability* casualty to a motorcyclist. The result is inconclusive regarding increasing the number of children at 95% statistical confidence.

As before, using the three category version of the education variable gives an increase from 0.17 to 0.20, although the education parameters are not in themselves significant. This is shown in Table 7.28, where it can be seen that the values, signs and significance of the other variables have remained the same or very similar to the first model of the 50% risk reduction in *serious with disability* casualty to a motorcyclist.

Table 7.28 Results of the Second Model for 50% Reduction in Risk of Serious with Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Choice IDR 5,900			
Constant	0.83*	0.40	2.30
Age	**-0.06**	**0.02**	0.94
Income/10,000	**0.02**	**0.00**	1.02
Number of children	0.14*	0.44	1.16
Education			
High school and under	-0.58*	0.42	0.56
Undergraduate student	0.59*	0.45	1.81
Observations	182		
LL (O)	-116.75		
LL (ρ)	-92.94		
ρ^2	0.20		

Note: * Please note these results are statistically not significant at best 90% level of confidence

Source: This study

7.5.3 Summary of the Binary Models of Serious with Disability Casualty

Both the binary logit models' results, discussed above, demonstrate similar patterns to previous models, which are the amount of willingness to pay for either a 25% or a 50% risk reduction in *serious with disability* casualty to a motorcyclist following an accident is at the 95% level of statistical significance and is affected by:

- Age: increasing age, holding everything else constant, decreases the probability that an individual would be willing to pay either IDR 3,000 for a 25% risk reduction or IDR 5,900 for a 50% risk reduction in a *serious with disability* casualty to a motorcyclist.
- Income: increasing income, holding everything else constant, increases the probability that an individual would be willing to pay either IDR 3,000 for a 25% risk reduction or IDR 5,900 for a 50% risk reduction in a *serious with disability* casualty to a motorcyclist.
- Number of children in the family: number of children in a family holding everything else constant, increases the probability that an individual would be willing to pay either IDR 3,000 for a 25% risk reduction or IDR 5,900 for a 50% risk reduction in a *serious with*

disability casualty to a motorcyclist. However, this parameter is not statistically significant in the 10% level in either risk reduction scenario and it was found that the 25% risk reduction has better significance than a 50% risk reduction.

Both binary models looking at *serious with disability* casualty to a motorcyclist predict similar patterns of probabilities for individuals with the same characteristics (a comparison of Table 7.23 and Table 7.26); however, there are higher probabilities that people would choose the 25% reduction than the probability that they would choose the 50% reduction.

7.5.4 Interpretation of the Multinomial Model of Serious with Disability Casualty (IDR 5,900; IDR 3,000; IDR 0)

This multinomial model of a *serious with disability* casualty to a motorcyclist considers the respondents' choices between paying IDR 3,000 or IDR 5,900 to reduce the risk of the casualty as a result of a motorcycle accident by 25% or 50% respectively relative to paying nothing (unwilling to pay). In this context, being unwilling to pay, which is WTP IDR 0, is the baseline case for the analysis.

Table 7.29 Results for the Multiple Choices Model for Reduction in Risk of Serious with Disability Casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Alternative Specific Constant			
Choice IDR 5,900	**3.33**	**0.00**	
Choice IDR 3,000	**2.08**	**0.02**	
Choice IDR 5,900			
Age	**-0.13**	**0.00**	0.88
Income/10,000	**0.02**	**0.00**	1.02
Number of children	**0.22**	0.35	1.25
Choice IDR 3,000			
Age	**-0.10**	**0.01**	0.91
Income/10,000	**0.01**	**0.02**	1.01
Number of children	0.36	0.14	1.44
Observations	182		
LL (O)	-171.53		
LL (ρ)	-153.06		
ρ^2	0.11		

Source: This study

Overall, the model shows that a significant relationship exists between the dependent variable of the WTP choices and the independent variables included in the model; however, the number of children in the household does not have significant results (Table 7.29).

The logit model which predicts a choice of being willing to pay IDR 5,900 for a 50% reduction in the risk of *serious with disability* casualty to a motorcyclist versus ignoring the risk reduction and choosing the option of WTP IDR 0 is:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 3.33 - 0.13\ Age + 0.02\ Income + 0.22\ Number\ of\ children$$

and that which predicts a choice of being willing to pay IDR 3,000 for a 25% reduction in the risk of *serious with disability* casualty to a motorcyclist versus ignoring the risk reduction and choosing the option of WTP IDR 0 is:

$$Logit(p) = \log\left[\frac{p}{1-p}\right] = 2.08 - 0.10\ Age + 0.01\ Income + 0.36\ Number\ of\ children$$

These two predictors are valid at 90% level of statistical confidence. Similar to the previous models, it is more useful for this study to be able to consider the probabilities associated with the WTP. Using the same example as in the binary cases of an individual 20 years old with an income of IDR 750,000 and no children, then a calculation can be made to predict the probability that this person would be WTP in each of the three categories in this model, namely WTP IDR 0, being WTP IDR 3,000 and being WTP IDR 5,900. By using the example with no children, the result is not affected by the lower statistical significance of the number of children variable.

As with analysis process in the *slight* casualty case, first the parameters in Table 7.29 are substituted into the probability formula, then the probability results for each preferences model in turn, as follows:

Preference 1 (IDR 5,900) = $p_1 = e^{3.33 - 0.13\ Age + 0.02\ Income + 0.22\ Number\ of\ children}$

Preference 2 (IDR 3,000) = $p_2 = e^{2.08 - 0.10\ Age + 0.01\ Income + 0.36\ Number\ of\ children}$

Preference 3 (IDR 0)= $p_3 = e^{0}$

Next, substituting the values of the sample case which is age = 20 years and income = IDR 750,000 into the model above, the result would be:

$$p_1 = e^{3.33 - 0.13\,x20 + 0.02\,x(750000/100000) + 0.22\,x0} = e^{2.37} = 10.74$$

$$p_2 = e^{2.08 - 0.10\,x20 + 0.01\,x\,(750000/100000) + 0.36\,x0} = e^{1.18} = 3.25$$

$$p_3 = 1$$

So that the estimated probability that this person would be willing to reduce their risk in each of the three categories is:

$$p_1 = \frac{10.74}{10.74 + 3.25 + 1} = 0.72$$

$$p_2 = \frac{3.25}{10.74 + 3.25 + 1} = 0.22$$

$$p_3 = \frac{1}{10.74 + 3.25 + 1} = 0.07$$

Since the first model has the highest estimated probability, this multinomial model would predict that the individual under consideration would belong to this model category; i.e. that a person who is 20 years old and has an income of IDR 750,000 with no children would be WTP IDR 5,900 to reduce risk by 50%.

Predicted probabilities for individuals with different characteristics are tabulated in Table 7.30. This table emphasises some of the interesting features worthy of note that result from the calculation of predicted probabilities.

Similar to the previous multinomial models, it is very difficult to identify the characteristics of an individual who is predicted to be WTP IDR 3,000 over paying nothing. This is most likely due to the fact that very few respondents chose this option. Differences in characteristics appear to make the predicted probability that the individual will either be WTP IDR 5,900 or nothing more likely.

Table 7.30 Probability of Difference Characteristics of a Serious with Disability Casualty to a Motorcyclist

Age (years)	Income (IDR)	Number of Children	Logit p_1	Exp(β) of p_1	Prob p_1	Logit p_2	Exp(β) of p_2	Prob p_2	Exp(β) of p_3	Prob p_3
20	750000	0	2.37	10.74	0.72	1.18	3.25	0.22	1.00	0.07
20	1000000	0	2.93	18.72	0.77	1.52	4.59	0.19	1.00	0.04
20	1250000	0	3.49	32.64	0.81	1.87	6.49	0.16	1.00	0.02
20	1500000	0	4.04	56.92	0.85	2.22	9.16	0.14	1.00	0.01
20	750000	1	2.59	13.39	0.70	1.54	4.68	0.25	1.00	0.05**
8820	750000	2	2.81	16.69	0.68	1.91	6.73	0.28	1.00	0.04**
20	750000	3	3.04	20.81	0.66	2.27	9.68	0.31	1.00	0.03**
20	750000	4	3.26	25.95	0.63	2.63	13.93	0.34	1.00	0.02**
40	750000	0	-0.25	0.78	0.35	-0.75	0.47	0.21	1.00	0.44
40	1000000	0	0.31	1.36	0.45	-0.41	0.67	0.22	1.00	0.33
40	1250000	0	0.86	2.37	0.55	-0.06	0.94	0.22	1.00	0.23
40	1500000	0	1.42	4.14	0.64	0.28	1.33	0.21	1.00	0.15
40	750000	1	-0.03	0.97	0.37	-0.39	0.68	0.26	1.00	0.38**
40	750000	2	0.19	1.21	0.38	-0.02	0.98	0.31	1.00	0.31**
40	750000	3	0.41	1.51	0.39	0.34	1.40	0.36	1.00	0.26**
40	750000	4	0.64	1.89	0.38	0.70	2.02	0.41	1.00	0.20**
50	750000	0	-1.56	0.21	0.15	-1.72	0.18	0.13	1.00	0.72
50	1000000	0	-1.00	0.37	0.23	-1.37	0.25	0.16	1.00	0.62
50	1250000	0	-0.45	0.64	0.32	-1.03	0.36	0.18	1.00	0.50
50	1500000	0	0.11	1.12	0.43	-0.68	0.51	0.19	1.00	0.38
50	1500000	1	0.33	1.39	0.45	-0.32	0.73	0.23	1.00	0.32**
50	1500000	2	0.55	1.74	0.46	0.05	1.05	0.28	1.00	0.26**
50	1500000	3	0.77	2.16	0.46	0.41	1.50	0.32	1.00	0.21**
50	1500000	4	0.99	2.70	0.46	0.77	2.17	0.37	1.00	0.17**

Note: ** Please note these probabilities are not statistically significant at the 90% level of confidence

Source: This study

At the age of 20, changes in income (over the range IDR 750,000 to IDR 1,500,000) or changes in the number of children in the household (from 0 – 4) do not change the probability that such an individual will be in the group that chooses WTP IDR 3,000 at a level of 90% statistical significance. Unlike cases with the age of 20, at the age of 50, the switch takes place at all income ranges (IDR 750,000 – IDR 1,500,00) or changes in the number of children in the household (0 – 4). Interestingly, at the age of 40, the predicted probability found that an individual will switch at many different levels of income and number of children.

As with the binary models, the multinomial model shows an improved fit when the education variable is included with age, income/10,000 and number of children, as illustrated in Table 7.31.

Table 7.31 Results of the Second Multiple Choices Model for Reduction in Risk of Serious with Disability casualty to a Motorcyclist

Variable	Parameter	P-value	Exp (β)
Alternative Specific Constants			
Choice IDR 5,900	**3.70**	**0.00**	
Choice IDR 3,000	2.48	0.07	
Choice IDR 5,900			
Age	**-0.12**	**0.00**	0.89
Income	**0.02**	**0.00**	1.02
Number of children	0.26	0.27	1.30
Education			
High school and under	-1.00	0.27	0.37
Undergraduate student	-0.32	0.74	0.72
Choice IDR 3,000			
Age	**-0.11**	**0.00**	0.90
Income	**0.01**	**0.02**	1.01
Number of children	0.33	0.18	1.39
Education			
High school and under	0.18	0.86	1.20
Undergraduate student	-0.77	0.49	0.46
Observations	182		
LL (O)	-174.01		
LL (ρ)	-148.98		
ρ^2	0.14		

Source: This study

Again these results demonstrate an overall statistically significant relationship with the value of ρ^2 rising from 0.11 to 0.14 (significantly different from zero with a p-value of 0.00). However, the variable of education is not statistically significant at the 5% level or even the 10% level, so there is no predictive value from this variable in relation to the choices of WTP IDR 5,900 or IDR 3,000 over paying nothing.

7.5.5 Summary of the Multinomial Model of Serious with Disability Casualty to a Motorcyclist

The multinomial model results for *serious with disability* discussed above support the findings identified in the binary models in relation to age, income/10,000 and number of children in the family. In terms of prediction, this model is more useful as an estimator of the predicted probabilities and highlights some interesting features. These include an individual of age 50 will switch between being WTP IDR 5,900 and WTP IDR 0 at certain incomes (IDR 1,500,000) and, at the age 40, together with four children, individuals will switch into WTP IDR 3,000. The multinomial model gives more insight into potential behavioural responses to a WTP discussion over the binary models, where the only choice is to pay something or to pay nothing.

7.6 Summary of the Willingness to Pay Value of Motorcyclists Using Discrete Choice Models

In this next section an overview of the key findings, in turn, for each class of accident across the 3 models will be set out before the concluding remarks.

7.6.1 Slight Casualty to the Motorcyclist

Binary choice models: All parameters of the variables tested in both binary models achieved a very good level of statistical significance, with the parameters being statistically significant to a 95% level of confidence. The two models exhibit similar $\bar{\rho}^2$, as shown in Table 7.1.and 7.4.

The results suggest that, theoretically, increasing the cost of option will reduce the probability of an individual choosing that as a preference, and the results presented in Table 6.9 support this well establish finding. However, one particular observation from this study was the reduced probability between preferences of an individual choosing IDR700 to reduce by 25% the risk of *slight* casualty to a motorcyclist and IDR1,300 for reducing the risk by 50% was found to be only about 1.65%. This may be due to the parameters and their level of statistical significance, as well as the significance of goodness of fit, being quite similar in both binary models. In turn, this may be due to the under-representation of the population group with children in the sample survey.

Multinomial choice model: Unlike in the binary models results, where the probability is slightly lower for an individual choosing the higher payment, in the multiple choice model, the highest proportion of individual preferences were for the IDR1,300 of IDR 0 (model 1), rather than IDR 700 of IDR 0 (model 2). However, both preferences were implied by the model output which achieved a good level of statistical significance at 95% or better.

Overall: Both binary and multinomial choice models of the subjective costs of *slight* casualty to a motorcyclist perform well, which can be inferred from the levels of significance. Unlike in the binary choice models, where the individual preferences for the higher amount were slightly reduced, in the multinomial choice model, most people preferred IDR 1,300 rather than IDR 700, as illustrated in Table 6.9. Respondents were more than three times more likely to choose the sum of IDR 1,300 over IDR 700. This reflects the relative affordability for a higher proportion of the Indonesian population.

7.6.2 Serious with no Disability Casualty to a Motorcyclists

Binary choice models: Unlike the *slight* casualty case, not all of the variables tested on both binary models achieved statistical significance at the 5% level. The non-significant variable at the 5% level is the number of children; nonetheless, this variable is significant at the 10% level, as shown in Table 7.14 and Table 7. 17.

As with the *slight* casualty case, increasing the cost will reduce the probability of an individual choosing the higher cost option; see Table 6.10. The reduced probability that an individual will prefer to pay IDR 2,500 to reduce by 25% the risk of a *serious with no disability* casualty to a motorcyclist rather than IDR 4,200 to reduce risk of the same casualty by 50% was 19%. This may be the reason why the parameters on both binary models perform slightly different. The income variable in both binary models, however, was very similar.

Multinomial choice model: Similar to the multiple choice model of *slight* casualty to a motorcyclist, where the probability of an individual choosing the high payment was slightly higher, the individual choices for the IDR 4,200 or IDR 0 (model 1) is 1.7 times higher than the preference for the IDR 2,500 or IDR 0 (model 2).

Like the binary choice models of the *serious with no disability* case, the parameter of the number of children is not significant at the 5% level.

Overall: Whether using binary or multinomial choice models of the subjective costs of *serious with no permanent disability* casualty to a motorcyclist, the parameter of the number of children did not achieve significance at the 5% level. Like the motorcyclist *slight* casualty model, the binary choices of individuals are reduced marginally for higher cost, while in the multinomial choice model, most people chose the IDR 4,200 option rather than IDR 2,500 option. However, the number of individuals who chose to pay more in the multiple choice model was reduced by a reasonable margin compared with the *slight* casualty case (1.7 times against 3 times). This may be because people started to compare the amount that individuals had to be willing to pay on the one hand and the number of the probability of reducing risk on other. As an indication of the relative value of the IDR, at the time this study was being carried out in 2006, people could have bought a school meal for around IDR 4,000 and poor people could have bought a lunch for as little as IDR 2,500.

7.6.3 Serious with Disability Casualty to a Motorcyclist

Binary choice models: In the *serious with no disability* casualty to a motorcyclist case, the number of children tested on both binary models did not achieve statistical significance at 5%, but was at best at the 10% level of confidence; see Tables 7.23 and 7.26.

As the results presented in Table 6.11 show, the *serious with disability* cases follow a similar pattern to the two previous classes, the *slight* casualty and the *serious with no disability* cases; namely, increasing the cost of a choice reduces the probability of individuals' making that choice. The reduced probability between preferences of individuals for IDR 3,000 to reduce the risk to a motorcyclist by 25% and IDR 5,900 to reduce the risk by 50% of a *serious with disability* casualty to a motorcyclist is 15%.

Multinomial choice model: As with the previous multiple choice model, the *slight* casualty and the *serious with no disability* casualty to a motorcyclist, in the *serious* *with disability* to a motorcyclist case the probability is marginally higher that an individual will choose the option with the higher payment. The individual preference for the IDR 5,900 of IDR 0 (model 1) is 2.4 times higher than IDR 3,000 of IDR 0 (model 2).

As in the binary choice models of *serious with disability* casualty to a motorcyclist, the parameter of the number of children is not significant at the level of 5%, but at best at the 10% level of confidence.

Overall: Using both the binary and the multiple choice models of the subjective costs of *serious with disability* casualty to a motorcyclst, the parameter of the number of children was not statistically significant at the level of 5%. Similar to the models of the *slight* casualty and the *serious with no disability* casualty to a motorcyclist on the binary choices, the individual preferences were marginally reduced for the higher cost options, while in the multinomial choice model, most respondents chose IDR 5,900 rather than IDR 3,000.

However, the individuals preferring to pay more in the multiple choice model was reduced in comparison with the *slight* casualty case (2.4 times as against 3 times). As suggested above, this might be as a result of people considering how else they could spend their money when deciding upon what they would be willing to pay for risk reduction.

7.7 Summary

A binary logit model was initially selected in order to model peoples' willingness to pay for risk reduction with regard to motorcycle casualties in a developing country, taking into consideration the fact that two choices are simple and easily followed by the respondents. However, a multinomial logit model will present more detailed choices to the respondents, and therefore it was also used in the analysis. In the developed multinomial logit model 3, choices are considered to provide detailed analysis, but no more than 3 options are considered in order to avoid confusion.

For this reason, for the purpose of modelling motorcyclist casualty costs for three types severity based on the Willingness to Pay method, three models for each were developed, two being binary logit models and the third a multinomial logit model. These were chosen because they produce to a good insight into the value of the subjective cost based on the Willingness to Pay method.

Using both binary and multinomial choice models, the subjective costs of *slight* casualty to a motorcyclist performed well as as is implied by the level of statistical significance achieved at 95% confidence; although, some of the parameters for *serious with no disability* and *serious with disability* do not achieved the level of statistical significance at 90% confidence , however the level of statistical at best fit 90% confidence level then less some important insights into the WTP were achieved.

From this study, there is evidence for the key independent variables at 95% statistical confidence levels for income, age and number of children for slight injury casualty resulting from a motorcycle accident; however, the statistical confidence reduces to 90% when considering the case of serious with no disabiltiy. This fall in the level of confidence in the predictor when considering the case of serious with disability, may be due to the following factor; namely, the insignificantly high sample of the population. The lack of representation in the sample of individuals with 1,2,3,4 children where the number of children was significant for the non-serious case led to the decision to continue with the analysis considering only 3 variables, but at a reduced level of statistical confidence. An alternative approach would have been do a re-run of the case of serious with disability, without taking into consideration the number of children and, in turn, to produce a separate predictor based on 2 variables only.

As all the models performed well, they will be used to value the WTP value as intangible cost on the Willingness to Pay, the results of which will be presented in Chapter 8.

Chapter 8: VALUING A MOTORCYCLIST CASUALTY

8.1 Introduction

This chapter presents the results of the analysis of the data collected from the Stated Preference (SP) surveys. The casualties are considered under three categories, slight, serious with no disability and serious with disability. This study defines slight casualty as being when the victim suffers slight injury that doesn't require any hospital stay. The case of serious with no disability is defined as when the casualty suffers serious injury which requires a hospital stay, but doesn't suffer permanent disability. While the case of serious with disability is defined as when the casualty receives hospital treatment due to an injury that leads in to a permanent disability as a result of the accident. The value of motorcyclist casualty is broken down into three cost components, direct, indirect and intangible costs. The definition of each cost component is presented in section 8.2 and this is followed by the calculation of the direct, indirect and intangible costs. Finally, a sensitivity analysis of the Willingness to Pay (WTP) value is predicted with respect to the changes.

8.2 Definitions of Cost Components

The definition of cost components differs between studies. Widyastuti et al. (2007) and Dissanayake et al. (2008) discussed the difference between the cost components in the Gross Output and WTP methods. Gross Output includes the direct cost, gross lost output and human cost which in this study is termed subjective cost. While the value of a casualty based on the WTP composes direct cost, net lost output and WTP value. The differences in assessment between the Gross Output and WTP methods was explained earlier in Chapter 2 and the principle of the methodology is reviewed below:

Jones-Lee (2003) valued a fatality as follows:

$$VPF = WTP + NO + MA \quad (8.1)$$

Where:

VPF	=	Value per fatality
WTP	=	Willingness to Pay value, which is the amount that the people are willing to pay for risk reduction

NO = Net lost output (Net lost production)

MA = Medical and ambulance (direct cost)

whilst

$$NO = GO - C \quad 8.2$$

Where:

GO = Gross lost output (Gross lost production)

C = Future Consumption

Then the value of fatality can be written as follows:

$$VPF = WTP + (GO - C) + MA \quad 8.3$$

This definition is comparable to that proposed by Evens (2006); given that accident types were limited to *slight* and *serious* casualties the future consumption (C) may be neglected as the consumption has only been considered for people who were victims of premature death before they retired, as a result of the accident. The consumption is assumed to be the future consumption loss as a result of premature death. Therefore, the value per casualty based on the Gross Output method is calculated as:

$$VPC = MA + GO + HC \quad 8.4$$

Where:

VPC = Value per casualty based on the Gross Output method

HC = Human cost, which covers pain, grief and suffering

Given that the value of casualty based on the WTP method is calculated as:

$$VPC = MA + (GO - C) + WTP \quad 8.5$$

And since $C=0$ for slight and serious casualties, then

$$VPC = MA + GO + WTP \quad 8.6$$

Where:

VPC = Value per casualty based on the Gross Output method

HC = Human cost, which covers pain, grief and suffering

Several studies, including Trawen et al. (2001), Transport Research Laboratory (TRL) (1995), and Ross Silcock and Transport Research Laboratory (2003), defined the net/gross lost output as the loss of productivity of the casualty which is also considered in this study.

Human cost, which covers pain, grief and suffering of the casualty in the Gross Output method, is intangible, individual and subjective, and therefore is referred to as the Subjective cost. In the WTP method, the WTP value is the amount that people are willing to pay for risk reduction.

The Gross Output method values the subjective cost using a fixed percentage, while the WTP method uses the WTP value, which was analysed from individual preferences on the degree of risk reduction. Both methods determine the direct cost in the same way. On the other hand, analysing indirect cost, the Gross Output method adopts the gross loss of productivity for all casualty classes, whereas the willingness to pay method uses the net basis for fatalities and the gross basis for non-fatal casualties. Because fatal casualties are not considered, the loss of productivity is calculated in a similar way to the Gross Output method.

The following sections discuss the process of calculating the relevant cost components of the Gross Output and WTP methods.

8.3 Direct Cost

Direct cost is the total of all direct expenses of those items that are incurred as a result of a motorcycle accident. The cost items belonging to direct costs were collected by interviewing the motorcycle casualties. The direct cost included the following costs incurred, namely: at the scene of the accident, in hospital costs, out-patient costs, psychotherapy costs, administration costs, vehicle repair costs and other costs.

These are elaborated below:

1. Cost at scene is the cost incurred at the place of the accident, which includes first aid and/or transportation to the hospital.
2. Hospital cost is the cost that casualties paid while they were staying at hospital for treatment as an in-patient.

3. Out-patient cost is the cost incurred due to medical treatment received when not actually resident at the hospital; for example, treatment at a clinic.
4. Physiotherapy is the cost incurred for physiotherapy treatment.
5. Administration cost is the cost incurred for payments related to police and insurance charges.
6. Vehicle repair cost refers to money paid by casualties for repairing their vehicle after the motorcycle accident.
7. Other costs are those direct expenses relating to the accident, which are not included in the items above, such as payment to third parties.

The total direct cost is the sum of all direct costs identified above, which can be formulated as follow:

$$\overline{C_i} = \sum_{i=1}^{N} C_i \qquad 8.7$$

$$\overline{DC} = \frac{\overline{C_i}}{N} \qquad 8.8$$

Where:

n	=	all items of the direct cost (7 items)
$\overline{C_i}$	=	mean of each item of the direct cost
DC	=	total direct cost
N	=	total number of individuals in the database

Three types of direct cost will be determined based on the severity classes which are *slight*, *serious with no disability* and *serious with disability*. The direct cost of each type of severity is explained in more detail below, in sub-sections 8.3.1, 8.3.2 and 8.3.3.

8.3.1 Slight Casualty

Fifty people who had experienced *slight* casualties were interviewed for the purpose of this study. The interviews were carried out at the home of the casualties.

The sample was predominantly male (86 % of total respondents). As shown in Figure 7.1, 56% of the sample fell into the age range 20-29. This is consistent with the total number of accidents, as referred to in chapter 3, reported by police, which suggests that most motorcycle casualties are between 20 and 29 years old (Refer Chapter 4, Figure 4.13)

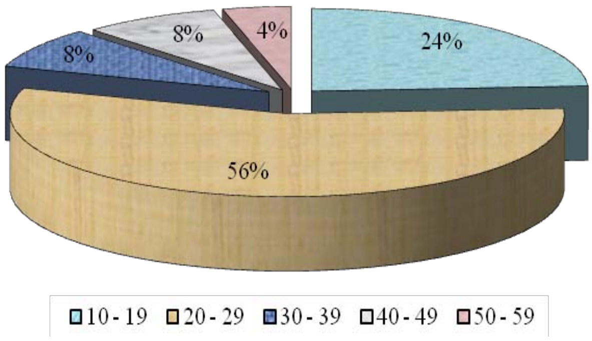

Figure 8. 1 Age Distribution of Slight Casualties
Source: This Study

According to the data, *slight* casualties do not incur all items of the direct cost, for example physiotherapy cost. The highest share of the cost incurred by most *slight* casualties is on the vehicle repair cost, while the lowest is on the administration cost.

The total direct cost is the sum of all direct costs incurred above. Figure 8.2 shows that 14% of respondents paid nothing, but 40% of respondents paid more than IDR 100,000 with the maximum payment of IDR 867,500 (Table 8.1).

Table 8.1 Direct Cost Estimation of the Slight Casualty

Estimated	Amount (IDR)
Minimum	0
Maximum	867,500
Median	92,500
Mean	153,100

Source: This Study

It can be seen in Table 8.1 that the mean is higher than the median. As both tendencies have different results, it is normal to decide which of the two central tendencies is to be used. Normally the mean would be used when the data is symmetrically distributed, whereas the median would be used when it is skewed.

The mean is calculated by dividing the sum of all values by the number of data items, while the median represents the middle value of the all values, with 50% of values below and 50% above. However, since this data had 14% respondents who had to pay nothing, but more than 40% of respondents who had to pay more than IDR 100,000, with a maximum cost of over IDR 800,000, the mean which is higher than IDR 100,000 is more appropriately used. This is not far from the suggestion by Millir and Guria (1991) that it is better to use the mean value when the data has “weeded out” high values.

Compared with workers’ average monthly income of around IDR 750,000 in Surabaya in 2007 when the data was collected, the mean of total direct costs of motorcyclists’ *slight* casualty represents around 20% of average monthly earnings.

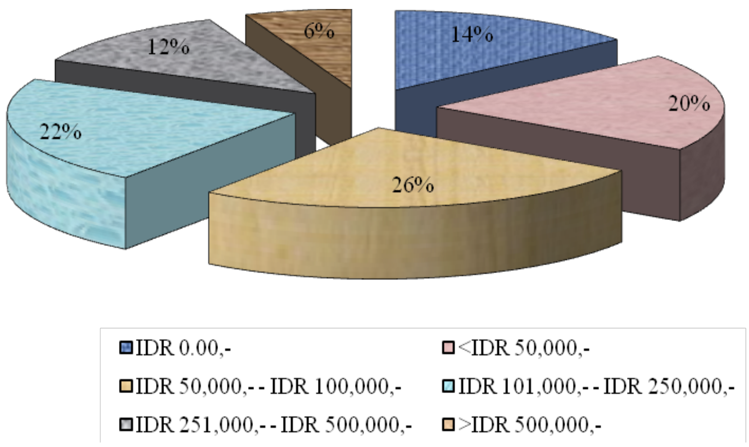

Figure 8. 2 Distribution of the Direct Cost of Motorcyclist Slight Casualty Respondents
Source: This Study

8.3.2 Serious with no Disability Casualty

Thirty seven responses were collected under the serious casualty category. This means casualties stayed in hospital for at least one day to recover from their injury. In this study, the serious casualties are divided into two casualty classes: those which are *serious with no disability* and those that are *serious with disability*. The responses were classified into these groups. In this study, the casualties that were permanently disabled in respect of their daily activity to any extent were categorised as *serious with disability* as a result of the motorcycle accident. On the other hand, the casualties who stayed in hospital, but recovered fully were categorised as serious with no disability. Of the 37 respondents, 27 were considered to be in the *serious with no disability* category and the other 10 casualties fell into the *serious with disability* category.

As with the *slight* casualties, the sample gender was predominantly male (81% of total respondents). As shown in Figure 8.3, 67% of the sample fell into the age range 20-29 years. This is even higher than in the case of *slight* casualty, but is still consistent with the accidents as reported in the police accident records. This suggests that most of motorcyclist casualties are between 20 and 29 year old (Refer to Chapter 4, Figure 4.13).

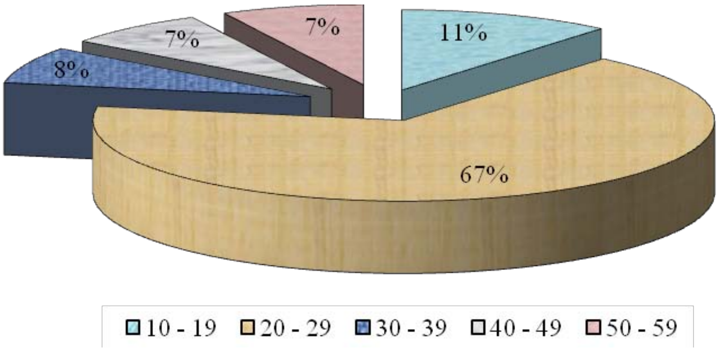

Figure 8. 3 Age Distribution of the Serious with no Disability Casualties
Source: This Study

Figure 8.4 shows that the total direct costs incurred by the *serious with no disability* category vary, with more than 40% of respondents being burdened with total direct costs of more than the modus value of IDR 4,200,000 (Table 8.2).

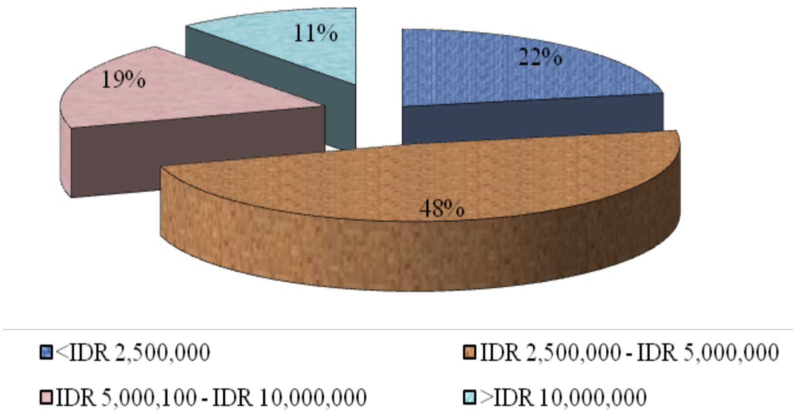

Figure 8. 4 Distribution of the Direct Cost of the Serious with no Disability Casualty
Source: This Study

Table 8.2 shows that the mean is higher than the median. Using the same consideration discussed above in 8.3.1, the mean is the preferred statistic, since this data has more than 40% of respondents who have to pay more than IDR 4,200,000 which is the mode. The maximum cost can reach more than IDR 22,500,000.

Table 8.2 Direct Cost Estimation of the Serious with no Disability Casualty

Descriptive statistic	Total direct cost (IDR)
Maximum	22,500,000
Minimum	860,000
Median	4,290,000
Mean	5,400,000

Source: This Study

The mean of total direct costs of the motorcyclists in the s*erious with no disability* category is greater than seven times the average monthly income of workers in Surabaya's in 2007, which was around IDR 750,000.

8.3.3 Serious with Disability Casualty

As suggested in Section 8.3.2, those casualties that are permanently disabled to any extent are categorised as being *serious with disability*. In this study there were 10 respondents who fell into this category. The numbers of respondents who were categorised as *serious with disability* is consistent with the police accident report which showed that the higher severity class has the lower the number of casualties (Refer Section 4.5.2).

As in the *slight* and *serious with no disability* casualties, the sample gender is predominantly male (70% of total respondents). In addition, 69% of the sample fell into the age range 20-29 years, which is also consistent with the police accident records (Refer Chapter 4, Figure 4.13).

On the basis of the data, it was found that the highest share of the cost incurred by the *serious with disability* casualties was the in-patient cost, whilst the lowest was the cost at scene. The total direct cost of motorcyclists in the case of *serious with disability* varies from the minimum of IDR 6,075,000 to the maximum cost of IDR 28,775,000 with the mean being IDR 16,100,000 (Table 8.3).

Table 8.3 Direct Cost Estimation of Serious with Disability Casualty

Descriptive statistic	Total direct cost (IDR)
Maximum	28,775,000
Minimum	6,075,000
Median	12,275,000
Mean	16,100,000

Source: This Study

Table 8.3 shows that the mean is higher than the median. Using the same consideration discussed above in 8.3.1, the mean is the preferred central, since in this data, 50% of respondents had to pay more than IDR 12,275,000 with the maximum cost reach more than IDR 28,775,000, and the mean tendency is preferred.

The mean of total direct costs of motorcyclists in the *serious with disability* category is greater than twenty-one times the average monthly income of workers in Surabaya, which in 2007 was around IDR 750,000.

8.4 Indirect Cost (The Loss of Productivity Cost)

The indirect cost is incurred indirectly from a motorcyclist accident. In this study, the indirect costs are referred to as the loss of productivity cost. For slight and serious casualties, the Gross Output and the WTP method apply the same procedure in order to calculate indirect cost. In other words, the future consumption of the casualty is not applicable for slight and serious cases (See equation 3.6).

8.4.1 Fornula for the Loss of Productivity Cost

The procedure to estimate the loss of productivity cost is explained in this section.

The Loss of productivity is the cost arising from casualties' loss of productive working time resulting from the accident. In this study, the loss of productivity is valued using the loss of casualties' working time multiplied by their income or wages.

$$\overline{LOPC} = \sum_{i=1}^{N} \left[LT(i) \times IW(i) \right] / N \qquad 8.9$$

$\overline{LOPC}$	=	Mean of the loss of productivity
LT (i)	=	Loss productive time of an individual *i* (in months)
IW(i)	=	Monthly income or wage of an individual *i*
N	=	Total number of casualties in the database

Sari and Sutomo (2004) reported the mean wages for Indonesian citizens according different age groups (Table 8.4) and these values were used when calculating the loss of productivity for casualties who had no job; for instance, housewives, students or children.

Table 8.4 Monthly Mean Wages (IDR)

Group age	Wages (IDR)
5 - 15	332,909.00
16 - 21	332,909.00
22 - 30	498,357.00
31 - 40	624,050.33
41 - 50	742,121.50
51 - 60	669,192.00

Source: Sari and Sutomo (2004)

8.4.2 Slight Casualty

According to the data, 38% of *slight* casualties experienced loss of productivity cost. This is because most of the *slight* casualty cases did not stay in hospital or at home being cared for, because the severity of their injury meant they could return to work directly. However, for casualties that were burdened with a cost, the minimum cost was IDR 11,097 (less than IDR 50,000) and the maximum was IDR 455,000 (higher than IDR 100,000) (Figure 8.5).

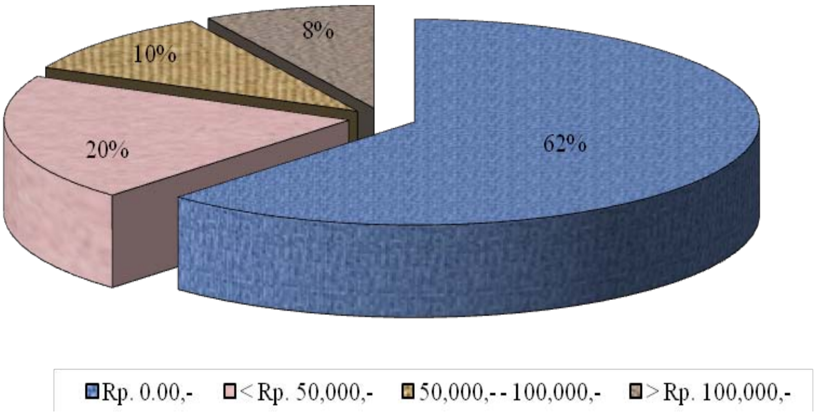

Figure 8. 5 Distribution of the Loss of Productivity Cost of Motorcyclists with Slight Casualty
Source: This Study

Since more than 50% of the respondents had no Loss of Productivity cost, the mode and median of this cost is IDR 0 (Table 8.5). When all the casualties are taken into account, the mean of the cost is IDR 32,000 (rounded).

Table 8.5 Loss of Productivity Cost of Motorcyclists with Slight Casualty

Estimated	Amount (IDR)
Minimum	0
Maximum	455,000
Median	0
Mode	0
Mean	32,000

Source: This study

8.4.3 Serious with no Disability Casualty

As with the motorcyclists with *slight* casualty cases, the wages of casualties without a job were based on the Sari and Sutomo (2004) study (Table 8.4). While for a casualty with a job, the loss of productivity is valued using the loss of the casualty's working time multiplied by their income.

The data in Figure 8.6 revealed that most of the respondents who had a *serious with no disability* casualty experienced a loss of productivity cost of less than IDR 500,000.

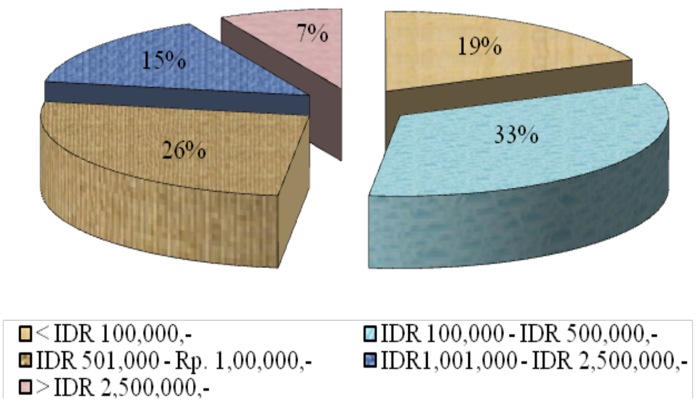

Figure 8.6 Distribution of the Loss of Productivity Cost of the Serious with no Disability Casualty
Source: This Study

The cost incurred ranged between a minimum cost of IDR 33,291 and the maximum of IDR 6,500,000 (Table 8.6) with the mean being IDR 970,000.

Table 8.6 The Loss of Productivity Cost of the Serious with no Disability Casualty

Descriptive statistic	Loss of productivity cost (IDR)
Maximum	6,500,000
Minimum	33,291
Median	420,833
Mean	970,000

Source: This Study

8.4.4 Serious with Disability Casualty

As with the previous cases in this section, the wages of the casualties who were not employed were assumed based on Sari and Sutomo's (2004) study (Table 8.4). For a casualty with job, the loss of productivity is valued using the loss of casualty's working time multiplied by their income.

Figure 8.7 show that most of the respondents who had a *serious with disability* casualty had experienced loss of productivity costs between IDR 2,501,000 and IDR 5,000,000.

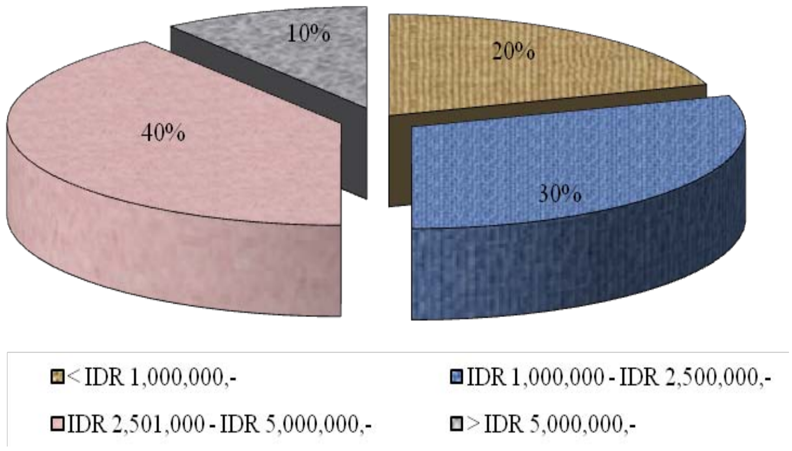

Figure 8. 7 Distribution of the Loss of Productivity Cost of the Serious with Disability Casualty
Source: This Study

Based on the data, the cost incurred ranged between a minimum cost of IDR 565,945 with the maximum cost reaching IDR 13,020,000 and the mean (rounded) at IDR 3,100,000 (Table 8.7).

Table 8.7 The Loss of Productivity Cost of the Serious with Disability Casualty

Descriptive statistic	Loss of productivity cost (IDR)
Maximum	13,020,000
Minimum	565,945
Median	2,665,000
Mean	3,100,000

Source: This Study

8.5 Intangible Cost

As stated above, in this study, the intangible cost of the Gross Output method is called the Subjective Cost, while being referred to as the WTP value in the WTP method. Both methods are explained below.

8.5.1 Subjective Cost in the Gross Output Method

Subjective Cost using the Gross Output method is identified as an amount which is added on top of the sum of direct and loss of productivity costs. The amounts are assumed to be 38% for a fatality, 100% for a serious casualty and 8%

for a slight casualty (TRRL (1995), Ross Silcock and Transport Research Laboratory (2003), Yefrizon and Malkamah. S (2004) and Sari and Sutomo (2004)). As stated in Chapter 2, these values are based on the UK experience and there is no explanation in these papers as to where these figures come from.

In this study, the slight and serious casualty categories only are being considered. Therefore, the values that will be used are 100% for the serious casualty categories (*serious with no disability* and *serious with disability*) and 8% for the *slight* casualty category.

The subjective cost of the Gross Output method would be:

Slight category

$$\overline{SCSl} = \sum_{i=1}^{N} \{8\% \times [DCSl(i) + LOPCSl(i)]\} / N \qquad 8.10$$

$\overline{SCSl}$	=	Mean of the subjective cost of *slight* casualty
i	=	The *slight* casualty no *i*
N	=	Total number of *slight* casualty casualties in the database
DCSl (i)	=	Direct cost of each *slight* casualty *i*
LOPCSl(i)	=	Loss of productivity of *slight* casualty *i*

Serious with no disability category

$$\overline{SCSnb} = \sum_{i=1}^{N} \{100\% \times [DCSnb(i) + LOPCSnb(i)]\} / N \qquad 8.11$$

$\overline{SCSbnd}$	=	Mean of the subjective cost of *serious with no disability*
i	=	The *serious with no disability* no *i*
N	=	Total number of casualties belonging to the *serious with no disability* category in the database
DCSbnd (i)	=	Direct cost of each *serious with no disability i*
LOPCSbnd(i)	=	Loss of productivity of *serious with no disability i*

Serious with disability category

$$\overline{SCSwd} = \sum_{i=1}^{N} \{100\% \times [DCSwd(i) + LOPCSwd(i)]\} / N \qquad 8.12$$

$\overline{SCSwd}$	=	Mean of the subjective cost of *serious with disability*

i	=	The *serious with disability* no *i*
N	=	Total number of casualties belonging to the *serious with disability* category in the database
DCSwd (i)	=	Direct cost of each *serious with disability i*
LOPCSwd(i)	=	Loss of productivity of *serious with disability i*

8.5.2 Willingness to Pay Method

As discussed in Chapter 6, respondents were asked about their choices with regard to risk reduction. Each respondent was requested to complete two binary choice questions and one multiple choice question regarding each type of severity of casualty. The questions were designed to elicit the respondents' preferences with regard to casualty reduction. Both Binary and Multinomial Choice models were used to calculate the WTP value. As discussed by Widyastuti et al. (2007) and Dissanayake et al. (2008) et al. (2008), the mean of WTP can be determined by multiplying the probability by the amount chosen for the willingness to pay for risk reduction. Then the value of a casualty can be calculated by dividing the mean of the Willingness to Pay amount by the change in statistical risk (Widyastuti et al. (2007) and Dissanayake et al. (2008) et al., 2008). This means that two stages are needed to estimate the value of casualty cost: calculation of the mean of willingness to pay and estimation of the cost. The equations for both stages are as follows:

Stage 1: Calculation of the mean willingness to pay

$$\overline{W} = \sum_{n=1}^{K}\left[\sum_{i}^{N} P_n(i)W(i)\right]/K \qquad 8.13$$

$\overline{W}$	=	Mean willingness to pay per individual
n	=	Each type of choices
K	=	Total number of options
N	=	Total number of individuals in the database
i	=	Each individual
$P_n(i)$	=	Probability that alternative *i* is chosen by individual *n*
W(i)	=	Willingness to Pay choice option (yes or no)

Stage 2: Estimation of the Value of Casualty Cost

$$VOCC = \frac{\overline{W}}{\beta} \qquad 8.14$$

VOCC	=	Value of casualty cost
$\overline{W}$	=	Mean WTP per individual to avoid risk
β	=	Change in statistical risk

In the following sections, for each category of casualty, *slight*, *serious with no disability* and *serious with disability,* firstly, subjective cost is calculated based on the Gross Output method and, secondly, WTP value is calculated based on the WTP value.

8.5.3 Slight Casualty

The Subjective Cost of the Gross Output Method

In the Gross Output method, the subjective cost is determined as the total of direct cost (Table 8.1) and loss of productivity (Table 8.5) multiplied by 8%. The result shows that the costs range from zero to a maximum of IDR 105,800. The mean of the subjective cost of a motorcyclist's *slight* casualty is rounded to IDR 14,800 (Table 8.8).

Table 8.8 The Subjective Cost of a Motorcyclist's Slight Casualty

Estimated	Amount (IDR)
Minimum	0
Maximum	105,800
Median	8,000
Mean	14,800

Source: This Study

Willingness to Pay Value of the Willingness to Pay method

As discussed in Chapter 6, where two cards with binary choices are presented to every respondent, WTP values for two types of risk reduction are given. The first model (binary 1) asks for the respondent's WTP an amount of IDR 700 for a 7/100,000 (25%) reduction in the risk of *slight* casualty and the second model (binary 2) asks about an amount of IDR 1,300 for a 14/100,000 (50%) reduction in risk. The mean of the first model is IDR 542 while the mean of the second model is IDR 986. The WTP value of the first and the second models are calculated as IDR 7,747,253 and IDR 7,040,816 respectively. The mean value, considering both models, is IDR 7,394,035 (Table 8.9).

Table 8.9 WTP Value of a Motorcyclist's Slight Casualty Derived from the Binary Choice Models

Model	Risk Reduction	Amount WTP query (IDR)	Average Probability (P= %)	Mean of the WTP (IDR)	Value of Casualty (VOC)
Binary 1	25%	700	0.77	542	7,747,253
Binary 2	50%	1300	0.76	986	7,040,816
The Average of VOC from the Binary model (IDR)					7,394,035

Source: This Study

In the Multinomial choices, respondents were asked their preference from three choices: IDR 0, IDR 700 and IDR 1,300. The respondents divided into three types of choices: some preferred the first choice and were willing to pay IDR 0 for 0% reduction in risk; the second group were willing to pay IDR 700 for a 25% (=7/100,000) reduction in risk; and the third group were willing to pay IDR 1,300 for a 50% risk reduction (=14/100,000). IDR 7,527,473 is the accumulated WTP from three results and is the WTP value of motorcyclists' *slight* casualty obtained from the multiple choice model (Table 8.10).

Table 8.10 WTP Value of a Motorcyclist's Slight Casualty Derived from the Multinomial Choice Model

Multinomial Choice Model	Risk Reduction	Amount WTP query (IDR)	Average Probability (P= %)	Mean of the WTP (IDR)	Value of Casualty (VOC)
Choice 1	0%	0	0.20	0	0
Choice 2	25%	700	0.18	127	1,813,187
Choice 3	50%	1300	0.62	800	5,714,286
The VOC from Multinomial model (IDR)					7,527,473

Source: This Study

The WTP value for a motorcyclist's *slight* casualty is then calculated using the average of the WTP values, which are determined from the Binary Choice and the multinomial choice model. IDR 7,500,000 (Table 8.11) is the rounded WTP value of motorcyclists' *slight* casualty from the Willingness to Pay method.

Table 8.11 The WTP Value of a Motorcyclist's Slight Casualty

Description	WTP Value (IDR)
The Binary model	7,394,035
The Multinomial model	7,527,473
The mean of the WTP	7,460,754
The WTP value (rounded)	7,500,000.00

Source: This Study

8.5.4 Serious with no Disability Casualty

The Subjective Cost of the Gross Output Method

Similar to the *slight* casualty case, the subjective cost of *serious casualty with no disability* is determined as the total of the direct cost and loss of productivity multiplied by a set percentage: 100% for serious casualty categories. Considering the Direct Cost shown in Table 8.2 and the Loss of Productivity Cost in Table 8.6, the results ranged between a minimum cost of IDR 993,291 and IDR 29,000,000 as a maximum. The mean of the subjective cost of a motorcyclist's *serious with no disability* casualty is rounded to IDR 6,400,000 (Table 8.12).

Table 8.12 The Subjective Cost of a Motorcyclists' Serious with no Disability Casualty

Descriptive statistic	WTP Value (IDR)
Maximum	29,000,000
Minimum	993,291
Mean	6,400,000
Median	4,848,424

Source: This Study

Willingness to Pay Value of the Willingness to pay Method

As discussed in Chapter 6, two sets of binary choices were presented to every respondent concerning two WTP amounts for two types of risk reduction. The first model (binary 1) asked about the WTP of a respondent the amount of IDR 2,500 for a 25% (=3/100,000) reduction in the risk of *serious with no disability* casualty; and the second model (binary 2) gave the option of IDR 4,200 for a 50% (=5/100,000) risk reduction. The mean of the first model was IDR 2,608, whilst the mean of second model was IDR 2,019. The WTP value of the first and second models was calculated to be IDR 67,307,692.31 and IDR 52,153,846.14 respectively. The mean value of both models was IDR 7,394,034.53 (Table 8.13).

Table 8.13 WTP Value of a Motorcyclist's Serious with no Disability Casualty Derived from the Binary Choice Model

Model	Risk Reduction	Amount WTP query (IDR)	Average Probability (P= %)	Mean of the WTP (IDR)	Value of Casualty (VOC)
Binary 1	25%	2,500	0.81	2,019	67,307,692
Binary 2	50%	4,200	0.62	2,608	52,153,846
The Average of VOC from the Binary model (IDR)					59,730,769

Source: This Study

For the multinomial choices, respondents were asked for their preference from three choices: IDR 0, IDR 2,500 and IDR 4,200. The respondents divided into three types of choice: the first group expressed a willingness to pay IDR 0 for 0% reduction; the second group were willing to pay IDR 2,500 for a 25% risk reduction (=3/100,000); and the third group were willing to pay IDR 4,200 for a 50% risk reduction (=5/100,000). The WTP value of motorcyclists' *serious casualty with no disability* accumulated from the three results of the multiple choice models was IDR 69,948,718 (Table 8.14).

Table 8.14 WTP Value of a Motorcyclist's Serious with no Disability Derived Casualty from the Multiple Choice Model

Multiple Choice Model	Risk Reduction	Amount WTP query (IDR)	Average Probability (P= %)	Mean of the WTP (IDR)	Value of Casualty (VOC)
Choice 1	0%	0	0.16	0	0
Choice 2	25%	2,500	0.31	769.23	25,641,026
Choice 3	50%	4,200	0.53	2,215.38	44,307,692
The VOC from Multinomial model					69,948,718

Source: This Study

The WTP value for motorcyclists' *serious with no disability* casualty was then calculated using the average of the WTP values which were determined from the binary choice and the multiple choice model. The rounded value of IDR 65,000,000 (Table 8.15) was the WTP value of a motorcyclist's *serious with no disability* casualty derived from the Willingness to Pay method.

Table 8.15 The WTP Value of a Motorcyclist's Serious with no Disability Casualty

Description	Subjective Cost (IDR)
The Binary model	59,730,769
The Multinomial model	69,948,718
The mean of the WTP	64,839,744
The WTP value (rounded)	65,000,000.00

Source: This Study

8.5.5 Serious with Disability Casualty

The Subjective Cost of the Gross Output Method

As with the *slight* casualty and the *serious with no disability* categories, the subjective cost of the *serious with disability* category is determined as the total of direct cost and loss of productivity multiplied by a fixed percentage, this being 100% for the serious casualty categories. Considering the Direct Cost in Table 8.3 and the Loss of Productivity Cost in Table 8.7, the results range between a minimum cost of IDR 8,265,945 and IDR 36,110,000 as a maximum. The mean of the subjective cost of a motorcyclist's *serious with disability* casualty is rounded to IDR 19,250,000 (Table 8.16).

Table 8.16 The Subjective Cost of a Motorcyclist's Serious with Disability Casualty

Descriptive statistic	Subjective cost (IDR)
Maximum	36,110,000
Minimum	8,265,945
Mean	19,250,000
Median	14,016,667

Source: This Study

Willingness to Pay Value of the Willingness to Pay Method

As discussed in Chapter 6, two sets of binary choice were presented to every respondent asking about two amounts of WTP for two types of risk reduction. The first model (binary 1) asked the respondents' WTP an amount of IDR 3,000 for a 25% (=1/100,000) reduction in the risk of *serious with disability* casualty; the second model (binary 2) asked the respondents' WTP an amount of IDR 5,900 for a 50% (=2/100,000) reduction. The mean of the first model was IDR 2,423, whilst the mean of second model was IDR 3,890. The WTP value of the first and second models was calculated as IDR 242,307,692 and IDR 194,505,495 respectively. The mean value considering both models was IDR 218,406,593.39 (Table 8.17).

Table 8.17 WTP Value of a Motorcyclist's Serious with Disability Casualty Derived from the Binary Choice Model

Model	Risk Reduction	Amount WTP query (IDR)	Average Probability (P= %)	Mean of the WTP (IDR)	Value of Casualty (VOC)
Binary 1	25%	3,000	0.81	2,423	242,307,692
Binary 2	50%	5,900	0.66	3,890	194,505,495
The Average of VOC from the Binary model (IDR)					218,406,594

Source: This Study

For the Multinomial Choices, respondents were asked their preference from three choices: IDR 0, IDR 3,000 and IDR 5,900. The respondents divided into three groups: the first group was willing to pay IDR 0 for a 0% reduction; the second group was willing to pay IDR 3,000 for a 25% reduction (=1/100,000); and the third group was willing to pay IDR 5,900 for a 50% risk reduction (=2/100,000). The accumulated WTP value from three results obtained from the multiple choice models (Table 8.18) was IDR 244,340,659 regarding the WTP for reduction in motorcyclists' *serious with disability* category.

Table 8.18 WTP Value of the Motorcyclist's Serious with Disability Casualty Derived from the Multinomial Choice Model

Multinomial Choice Model	Risk Reduction	Amount WTP query (IDR)	Average Probability (P= %)	Mean of the WTP (IDR)	Value of Casualty (VOC)
Choice 1	0%	0	0.18	0	0
Choice 2	25%	3,000	0.24	725	72,527,473
Choice 3	50%	5,900	0.58	3,436	171,813,187
The VOC from Multinomial model (IDR)					244,340,660

Source: This Study

The WTP value for a motorcyclist's *serious with disability* was then calculated using the average of the WTP values determined from the binary choice and Multinomial Choice models. The WTP value derived from the Willingness to Pay method of a motorcyclist's *serious with disability* casualty was (rounded) IDR 231,500,000 (Table 8.19).

Table 8.19 The WTP Value of a Motorcyclist's Serious with Disability Casualty

Description	WTP Value (IDR)
The Binary model	218,406,593
The Multinomial model	244,340,659
The mean of the WTP	231,373,626
The WTP value (rounded)	231,500,000.00

Source: This Study

8.6 Casualty Cost

No matter which methods are employed, the value of casualty is the sum of direct costs, indirect costs (Loss of Productivity cost) and intangible costs (subjective cost in the Gross Output method and WTP value in the WTP method). The formula has been determined as follows.

$$VOCC = \overline{DC} + \overline{LOPC} + \overline{IC} \qquad 8.15$$

$\overline{DC}$ = Mean of the Direct Cost

$\overline{LOPC}$ = Mean of the Loss of Productivity Cost

$\overline{IC}$ = Mean of the Intangible Cost

VOCC = Value of Casualty Cost

In this study, the value of casualty cost has been estimated using the Gross Output and the WTP methods. The differences in valuing casualty cost, using the Gross Output and the WTP methods, are present only in the estimation of the intangible cost. The assessment is presented below.

8.6.1 Gross Output Method

Previous studies, such as Transport Research Laboratory (1995) and Ross Silcock and Transport Research Laboratory (2003), categorised casualty severity into slight and serious casualty, while this study grouped casualty severity into *slight* casualty, *serious with no disability* and *serious with disability* casualty. Developed from the direct cost, the loss of productivity and the subjective cost of each type of casualty, the casualty cost of motorcyclist casualty for the three different categories is presented in Table 8.20.

Table 8.20 Motorcyclist Casualty Cost Based on the Gross Output Method

Casualty class	Direct Cost (IDR)	Loss of Productivity (IDR)	Subjective Cost (IDR)	Casualty Cost (IDR)
Slight	153,100	32,000	14,800	200,000
Serious with no disability	5,400,000	970,000	6,400,000	12,770,000
Serious with disability	16,100,000	3,100,000	19,200,000	38,400,000

Source: This Study

It can be seen from Table 8.20 that the casualty cost of the *slight* casualty class is IDR 200,000. This amount is approximately 25% of a worker’s monthly income. This cost is relatively small in comparison with the previous study, which was based on secondary data. In this study, the data included several respondents who opted to pay nothing for the direct cost and nothing for the loss of productivity cost which may explain the lower casualty costs. Another reason is that for the motorcyclist *slight* casualties some preferred to repair damage to the motorcycle themselves and to recover from the incident at home and did not require hospital treatment.

As seen in Table 8.20, serious casualty values have been derived, the *serious with no disability* and the *serious with disability*. These amounts are rather large compared with workers’ average monthly income in Surabaya, which was around IDR 750,000 in 2007 when the data was gathered. The value of *serious with no disability* is less than the previous study for the serious casualty, which was IDR 21,365,939, while the *serious with disability* is higher compared with the previous study of the serious casualty value.

8.6.2 Willingness to Pay Method

Similar to the Gross Output method, in the WTP approach, the cost of the motorcyclist casualty is the sum of the direct cost, the loss of productivity and the WTP value which are presented in Table 8.21 below.

Table 8.21 Motorcyclist Casualty Cost Based on the WTP Method

Casualty class	Direct Cost (IDR)	Loss of Productivity (IDR)	WTP Value (IDR)	Casualty Cost (IDR)
Slight	153,100	32,000	7,500,000	7,685,100
Serious with no disability	5,400,000	970,000	65,000,000	71,370,000
Serious with disability	16,100,000	3,100,000	231,500,000	250,700,000

Source: This Study

It can be seen in Table 8.21 that the value of the intangible cost, determined using the WTP method, is much higher than that from the Gross Output method. Previous studies stated that the value of a *slight* casualty based on the WTP method is 3.7 times that determined by the Gross Output method and 3.25 for the serious casualty category (Transport Research Laboratory (TRL), 1993). However, in this study, the ratios are much higher at 38 times the Gross Output method for the *slight* casualty category, more than 5 times for the *serious with no disability* and more than 6 times for *serious with disability* category. The ratio of the *slight* casualty is significantly greater than that found in the study by the Transport Research Laboratory (1993). The value of WTP offered on the questionnaire was derived from the baseline used to develop the WTP questionnaire which was based on the average of several previous studies; namely, Transport Research Laboratory (1993), Sweroad/Bina Marga (1995), Yefrizon and Malkamah (2004) and Sari and Sutomo (2004). Unfortunately, Yefrizon and Malkamah (2004) and Sari and Sutomo (2004) considered that a *slight* casualty meant that a person in fact was admitted to hospital because of injuries resulting from a transport-related accident and received treatment for less than 30 days; therefore the *slight* accident costs that they report are very high. This led to the high value of the WTP offered in this study. Most respondents, however, thought that a *slight* casualty referred to a person who had not received hospital treatment and could have been treated at home. This caused the accumulated direct and indirect cost during primary data collection to be rather low in comparison with secondary data used in previous accident cost studies in Indonesia and made the accident cost of *slight* casualty in previous studies rather high.

8.7 Discussion of the Results of this Research

Previous studies commonly classified casualties into two main classes: slight and serious. Many previous studies, including Dawson (1967), Transport Research Laboratory (1993) and Ross Silcock and Transport Research Laboratory (2003), classified casualties in the following way:

- A serious casualty is suffered by a person who has to stay in hospital as an "in-patient" for at least one day, either immediately or later, as a result of the accident. Ross Silcock and Transport Research Laboratory (2003) state that, in the UK, this category also includes those who die after 30 days.
- A slight casualty is suffered by a person who receives injuries such as a sprain or bruise where no stay in hospital is needed

As stated earlier (Refer Chapter 2), the 14th Indonesian decree (1990) classified casualty in a slightly different way:

- A serious casualty means that a person is admitted to hospital as a result of injuries from a transport-related accident and receives treatment for more than 30 days.
- A slight casualty means that a person is admitted to hospital because of injuries resulting from a transport-related accident and receives treatment for less than 30 days

However, Indonesian police accident records classify casualty in the same way as most of previous studies such as Dawson (1967), Transport Research Laboratory (TRL) (1993) and Ross Silcock and Transport Research Laboratory (2003)**,** and therefore, this study is based on the police classification. As the serious category consists of a wide range of casualty, in this study, serious casualty has been broken down into the two categories of *serious with no disability* and *serious with disability*.

Many previous studies have reported that most developing countries, including Indonesia, assess casualties and accident cost using the Gross Output method. This can also be seen from the reports published by the Asian Development Bank (ADB). This study investigates the casualty cost using both the Gross Output method, and the WTP method. The valuation process of these methods was presented in more detail in Chapters 7 and 8. Table 8.22 presents details of the cost components of each casualty class considering both methods.

Table 8.22 Comparison of the Cost Items of the Gross Output and WTP Method

Casualty Classes	Direct Cost (IDR)	Loss of Productivity (IDR)	Intangible Cost	
			Subjective Cost of Gross Output (IDR)	WTP Value (IDR)
Slight	153,100	32,000	14,800	7,500,000
Serious with no disability	5,400,000	970,000	6,400,000	65,000,000
Serious with disability	16,100,000	3,100,000	19,200,000	231,500,000

Source: This study

The results of the motorcyclist casualty costs of both methods are presented in Table 8.23

Table 8.23 Value of Motorcyclist Casualty

Casualty Classes	Value of Casualty	
	Gross Output (IDR)	WTP (IDR)
Slight	200,000	7,685,100
Serious with no disability	12,770,000	71,370,000
Serious with disability	38,400,000	250,700,000

Source: This study

Table 8.24 shows the results of both the Asian Development Bank (2009d) study and this study, using the Gross Output method and the classifications of casualties.

8.24 Comparison of the Casualty Cost of the Asian Development Bank Study (2009d) and this Study

Casualty Classes	Asian Development Bank (2009d) (IDR.)	This Study (IDR.)
Slight	6,082,118	200,000
Serious with no disability	21,365,939	12,770,000
Serious with disability		38,400,000

Source: This study

It can be seen from the table that the costs estimated are somewhat different. In this study, there are two types of serious injuries, *serious with no disability* and *serious with disability*, whilst the Asian Development Bank (2009d) had only one classification for all serious accidents. The difference between the results may be due to the assumptions made in the two studies such as:

- The Asian Development Bank (2009d) study classified casualty into slight and serious; however, their classification of the casualty was slightly different to this study. The Asian Development Bank classified casualty as follows: a serious casualty is a person who had to stay in hospital and receive treatment for more than 30 days, whilst a slight casualty is a person who had to stay in hospital and receive treatment for less than 30 days. For that reason, in the Asian Development Bank (2009d), a surgery cost is part of the medical component that has to be considered for slight casualty. However, the *slight* casualty classification in this study did not assume that the casualty would stay in hospital even for one day.
- Moreover, as stated above in this study, the category of serious casualty is broken down into *serious with no disability* and *serious with disability*; therefore, two kinds of serious cost calculations have been made.

Several studies carried out in Indonesia contained guidelines on how to convert the results of Gross Output calculations into WTP calculations; one such study was the Transport Research Laboratory (TRL) published in 1993. Table 8.25 shows the conversion results of both the Asian Development Bank (TRL) study and this study.

Table 8.25 Comparison of WTP Conversions

Casualty classes	TRANSPORT	This Study
Slight casualty	3.70	38.43
Serious with no disability	3.25	5.59
Serious with disability	3.25	6.53

Source: This study

It can be seen from Table 8.25 that the conversion factor in this study is much higher than the Asian Development Bank (TRL) (1993) recommended, particularly for slight casualty. It can be seen that the value of the slight casualty based on the Gross Output method is quite low; therefore the ratio between the WTP and the Gross Output is very high. The difference might be due to the fact that the WTP value for *slight* casualty reduction in this study is relatively low for Surabaya citizens.

According to the results shown in Table 8.23 above, it can be seen that the WTP value results seem more appropriate, as the value of *slight* casualty estimated by the Gross Output method is very low. Apparently, people are more willing to prevent themselves from having a road accident than was established by the WTP method measuring willingness to reduce high risk.

8.8 Testing Sensitivity of the Willingness to Pay Value with Respect to the Change of Income

As indicated in the previous chapter, the Gross Output method values the subjective cost using a fixed percentage, while the WTP method uses the WTP value which analyses individual preferences for risk reduction. In this study, the individual preferences were tested with individual characteristics: income, age and number of children. The results of empirical analysis, presented in Chapter 7, have shown that the estimated models can be used as an effective tool to represent the actual preferences of the people for motorcycle accident risk reduction. The income variable shows a positive sign and significant relationship to the WTP value. It suggests that income has a significant influence on people's WTP choices. Therefore, in this study, income can be considered as a strong variable in analysing policies related to motorcyclist casualty costs.

Table 8. 26 The Changes in WTP Value with Respect to Income Change (%)

Income change (%)	Different of casualty cost (%)		
	Slight	*Serious with no permanent disability*	*Serious with disability*
-40%	-8%	-11%	-12%
-20%	-3%	-5%	-5%
0%	0%	0%	0%
20%	3%	4%	4%
40%	5%	7%	8%
60%	7%	10%	11%
80%	8%	12%	13%
100%	9%	14%	15%

Source: This study

Table 8.26 and Figure 8.8 show the variation of casualty costs as income varies. It can be seen that increasing income can increase the casualty cost and it was found that people are more willing to pay with regard to the more severe classes of casualty. This finding is reasonable because people are normally influenced to pay more by the more severe cases.

When income changes from a baseline (0%) are compared, the results show that there is more change in the value of the percentage of casualty cost when incomes reduce rather than when incomes increase. Since there are greater changes when the percentages are decreasing, there is also a steeper gradient (Figure 8.8).

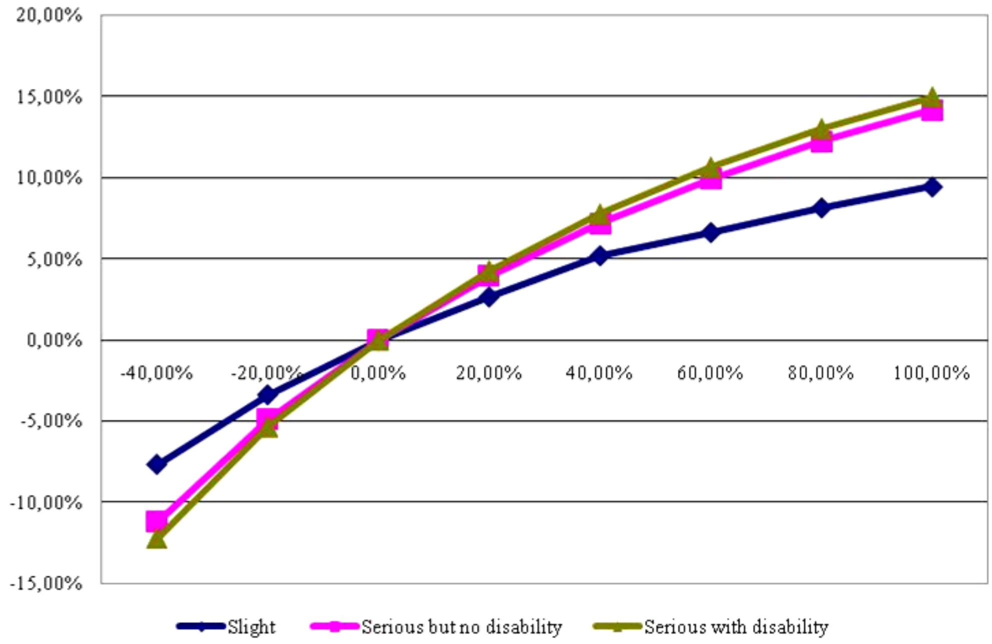

Figure 8.8 Effect of Income Change on the Motorcyclist Casualty Cost (%)
Source: This study

At the time of the data collection in 2006, the minimum wage was IDR. 685,500. Subsequently the minimum wage for workers in 2008 was IDR. 805,500 (Table 8.27), which represents an increase of approximately 10%.

Table 8.27 Minimum Wages of Surabaya Labour

Year	Minimum wage in Surabaya (IDR.)
2004	550,700
2005	578,500
2006	685,500
2007	746,000
2008	805,500

Source: This study

Given this increase in the wage rate between 2006 and 2008, the WTP values for *slight* casualty, *serious with no disability* and *serious with disability* have been increased by 2.3 %, 3.5% and 4.7% respectively (Table 8.28).

Table 8.28 WTP Value of Motorcyclist Casualty at 2008

Casualty class	Casualty cost change (%)	WTP Value (IDR.)	
		2006	2008
Slight	+ 2.3	7,500,000	7,675,500
Serious with no disability	+ 3.5	65,000,000	66,521,000
Serious with disability	+ 4.7	231,500,000	236,917,100

Source: This study

8.9 Summary

The value of a motorcyclist casualty is broken down into three cost components: direct, indirect and intangible. For both the Gross Output and WTP method, the direct costs and loss of productivity costs for slight and serious casualties are the same. The difference lies only in the intangible cost, which is the subjective cost in the Gross Output method and WTP value in the WTP method.

Using the Gross Output method, this study establishes the casualty cost of the *slight* category to be IDR 200,000, which is approximately 25% of a worker's monthly income. This cost is relatively small in comparison with the previous research which was based on secondary data. This is understandable, as respondents in this study thought that a *slight* casualty meant that a person did not need to stay in hospital, while previous studies defined a *slight* casualty as a person who was admitted for hospital treatment because of injuries that resulted from a transport related accident and received treatment for less than 30 days. The casualty cost of the *slight* category in the previous study is very high compared with this study (Table

8.23). Moreover, previous studies categorised severity into *slight* and serious while this study used 3 groups, splitting serious into 2 categories, to give *slight*, *serious with no disability* and *serious with disability*. The value of the *serious with no disability* is less and the *serious casualty with disability* is higher when compared to the value of serious casualty in previous studies.

The amount of the Intangible Cost determined from the WTP method is much higher than the cost based on the Gross Output method. A previous study stated that the value of slight casualty based on the Willingness to Pay method is 3.7 times greater than the Gross Output method and 3.25 greater for serious casualties (Transport Research Laboratory (TRL), 1993). However, in this study the ratios are much higher at 38:1 for the *slight* casualty category, more than 5:1 for the *serious with no disability* category and more than 6:1 for *serious with disability* category. The ratio of the *slight* casualty category is so much higher than Transport Research Laboratory (1993) because the respondents were willing to pay the amount presented to them, even though it was quite high, in order to reduce the risk of having *slight* casualties. Also, it might be due to the amount being offered as a trade-off to reduce the slight casualty still being within their reach.

Chapter 9: CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

For more than a decade, the growth in motorcycle numbers has been dramatic in Indonesia in general, and in Surabaya in particular. It is well known that, along with the increase in motorcycle numbers, there also is an increase in motorcycle accidents with the consequential loss of life, limb and suffering for those involved and their families. However, there has been little attention paid to investigating the financial burden that motorcyclists have to face when involved in road accidents. This burden should be considered, as the casualties not only have an impact on family circumstances, but also the general economy which experiences a loss of productivity resulting from such casualties. The research, presented in this thesis, has aimed to establish the value of motorcycle casualties using the Willingness to Pay and Gross Output methods. Casualty cost comprises of direct, indirect and intangible costs. Both methods estimate the value of direct and indirect cost in the same way, since in this thesis only *slight* and *serious* casualties are considered. However, there is a significant difference in valuing the intangible cost in these methods in that the Gross Output method uses a percentage whilst the WTP method uses the actual WTP value.

The data collection in this study was carried out using the stated preference (SP) techniques. Initially it was decided to perform the Contingent Valuation method for survey design. However, during the interviews, it was found to have some inconsistencies in the survey presentation; providing respondents with WTP choices in ascending or descending order seemed to significantly affect the WTP choices they made. Judging from this result, the data collection method was finally changed to the Choice Modelling method. The main data collection for this study was conducted during 2005 - 2006. In addition to motorcyclists, those individuals who had previously experienced either *slight* or *serious* casualty by being involved in motorcycle accidents were interviewed in order to collect the relevant information about direct costs, indirect costs and their preferences for risk reduction with respect to motorcycle accidents.

9.2 Have the Overall Aims and Objectives been Achieved

The following sections explain how these objectives were achieved in this study.

Objective 1: Investigate the suitability of the WTP method in valuing casualty cost in developing countries and analyse the possibility of the discrete choice model being used in the Willingness to Pay method

Many developing countries, including Indonesia, have assessed casualty and accident costs using the Gross Output method which values the intangible costs using the fixed percentage of the sum of the direct and indirect costs. In contrast, many developed countries, including the UK, have assessed these costs using the WTP method. Considering that intangible costs includes pain, grief and suffering or the wish to protect one from fatal injury, they are very subjective and individual because the amount varies for each individual depending on subjectivity and circumstances. With the Gross Output method, the subjective cost is determined with a fixed value for each individual, making it impersonal. However, with WTP value, the amount can be set individually according to the parameters, such as gender, age or income. Therefore, the WTP method should be applied in developing countries, including Indonesia, to give a picture of the intangible costs of a developing country citizen, in general, as part of the casualty cost.

Bateman et al. (2002) indicated that there are two approaches that can be used in the stated preference method, these being Contingent Valuation (CV) and Choice Modelling (CM). They suggested that CV should be used to obtain individual preferences, which are expressed as a monetary value. CM is based on attributes or characteristics which are embedded in the changing preferences that are offered. Since the Willingness to Pay approach has not yet been employed in Indonesia, in this research, the CM method was selected because, with the CM method, the questionnaire can be tailored to meet the objectives. Moreover, some parameters, which could guide the respondents, could be included in the CM's questionnaire. Changing brake pads is one of parameters that was included in the WTP questionnaire, the reason for this being that most motorcyclists in Surabaya tend not change their brake pads until they are really worn down, which is very dangerous as far as their safety is concerned.

Objective 2: Critically analyse the relative contribution of socio demographic information; for example age, gender, income, job status, size of household and WTP value.

Hammit (2000) recognised that the value of a statistical life depends upon wealth and might also depend on health. He concluded that the trade off between income and reducing risk could vary over the life cycle (age). Johansson (2002) agreed with this and suggested that the value of statistical life (VSL) could vary with age. Moreover, Jones-Lee (1989) and Horowitz and Connell (2003), found that there is a correlation between income or wealth as well as age and safety prevention. These circumstances apparently are analogous with the discrete choice principle, which was developed by Ben-Akiva and Lerman (1985) who stated that the discrete variables could be described from the behaviour of an individual person, household, or firm. They also stated that the development of disaggregate models, based on discrete choice analysis, was a major innovation in modelling analysis. Similarly, Bierlaire (1997) declared that the results of several decisions of each individual in the population would raise a choice or demand. Furthermore, Tamin (2000) confirmed that the probability of individuals choosing a given option is a function of their socioeconomic characteristics and the relative attractiveness of the option.

In addition, regarding accidents where motorcyclists are involved, Lin et al. (2003) and Rutter and Quine, (1996) stated that young and male motorcyclists have a stronger tendency towards risky behaviour. Similarly, Mannering and Grodsky (1995) mentioned that young and male motorcyclists perceived themselves to be at a greater risk of accidents. On the other hand, Chang and Yeh (2006) recognised that there is a correlation between accident risk, age and gender. They acknowledged that young and female riders, compared with their older and male motorcyclists, were more likely to be involved in an accident. But interestingly, female motorcyclists apparently had a higher accident risk than their male counterparts of the same age. Furthermore, Rutter and Quine (1996) identified that a young motorcyclist tends to exhibit high risk behaviour, such as a willingness to break the law and to violate the rules of safe riding, which plays a much greater role in accident involvement than inexperience.

Recognising that the impact of a motorcycle incident is not always the same between one motorcyclist casualty and another, especially in respect to the subjective costs, this study has valued a motorcyclist casualty by taking relevant characteristics, including age, income, number of family and gender into account and has used the stated preference method, modelled by discrete choice, in order to analyse the WTP value. This study found that age, income and number of children is most likely to show positive correlation with WTP and is significant at the 5% - 10% level. The fit of the model to the data is expressed by ρ^2 and this too falls within the expected range of 0 -1

Objective 3: Conduct a sensitivity analysis to investigate the changes on the WTP value due to the changes to the socio demographic variables that may be found to be significant in the developed method in Objective 3

As indicated in the previous chapter, the Gross Output method values the subjective cost using a fixed percentage, while the WTP method uses the WTP value which analyses individual preferences for risk reduction. In this study, the individual preferences were tested with individual characteristics: income, age and number of children. The results of empirical analysis presented in Chapter 7 have shown that the estimated models can be used as an effective tool to represent the actual preferences of people for motorcycle accident risk reduction. The income variable shows a positive sign and significant relationship to the WTP value. It suggests that income has a significant influence on people's WTP choices. Therefore, in this study, income can be considered as a strong variable in analysing policies related to motorcyclist casualty costs.

Objective 4: Conduct an in depth analysis to explore statistically significant similarities and differences of the casualty costs derived from the Gross Output method and WTP method in this study, as well as in other existing studies in *developing* countries in general and Indonesia in particular

It can be seen from the table 8.24 that the costs estimated are somewhat different. In this study, there are two types of serious injuries, *serious with no disability* and *serious with disability,* while the Asian Development Bank (2009a) had only one classification for all serious accidents. The difference between the results may be due to the assumptions made in the two studies such as:

- The Asian Development Bank (2009a) study classified casualty into the categories of slight and serious; however their classification of casualties is slightly different from this study. The Asian Development Bank classified casualty is as follows: a serious casualty is a person who had to stay in hospital and receive treatment for more than 30 days, whilst a slight casualty is a person who had to stay in hospital and receive treatment for less than 30 days. For this reason, in the Asian Development Bank study (2009a), a surgery cost was part of the medical component that had to be considered for slight casualty. In contrast, as far as this study is concerned, the *slight* casualty classification did not assume that the casualty would stay in hospital even for one day.

Moreover, as stated above in this study, the serious casualty category is broken down into *serious with no disability* and *serious with disability*; therefore, two kinds of serious cost calculations have been made.

A few points worth highlighting in this study are:

1. Previous studies show that valuing the casualty by using the WTP method is still uncommon in developing countries, including Indonesia (see chapters 2 and 3). Several studies did not pay attention to the use of the WTP method due to the complexities involved in questionnaire design. However, the Gross Output Method that has been in use in Indonesia over past years is very much based on UK studies. Furthermore, a lot of studies also suggest that WTP study can represent the reality regarding people’s willingness to prevent an accident. Therefore, there is a need to conduct a study to value casualties in Indonesia as a developing country using the WTP method. As elaborated in chapter 6, the choice modelling method was found to be more suitable for the purpose of investigating peoples’ WTP for risk reduction with respect to motorcycle casualties, due to the fact that the probability of an accident is something beyond repondents’ mind. Therefore the choice modelling method may give directions for the respondents to be able to generate accurate responses in the survey. Even so, in selecting choices, there should be a clear understandable sequence of choices for the respondents. In this study, the notion of brake pad change was considered as a main scenario due to the fact that Indonesian motorcyclists, in general, and in Surabaya in particular, are

reluctant to change brake pads until they are really worn down, even though they are a vital part of the safe and efficient mechanism of a motorcycle and may pose accident related risks if not satisfactorily maintained. It can be seen from the analysis that the Discrete Choice (DC) technique is an effective tool to estimate the WTP value.

2. Accordingly, two Binary and one Multinomial Logit models were considered with emphasis being placed on three classes of the severity of casualties: namely, *slight*, *serious with no disability* and *serious with disability*. The analysis highlighted income, age and number of children as key variables in the models considered. Among these variables, income and age were statistically significant at the 5% level for all three models of *slight*, *serious with no disability* and *serious with disability*. However, the number of children variable was estimated with a 5% level of statistical significance for *slight* casualties, and about 10% level of significance for *serious with no disability* casualties. This variable was not found to be a signicant variable for the case of *serious with disability* casualties. The fall in the level of confidence in the predictor when considering the case of serious with disability may be due to one or more of the following factors: namely, the insufficiently high samples of the population (based on 185 interviews), the lack of representation in the sample of individuals with 1, 2, 3,4 children, or a combination of both. The other reason is that individuals consider serious with disability casualties as a vital issue and therefore are willing to pay for reducing risk, regardless of taking into consideration their family composition.

The Gross Output Method, most often applied in the developing world, was applied to the data collected in this study. The value of a motorcyclist casualty was broken down into three cost components: direct, indirect and intangible. Within these definitions, the Gross Output and the WTP method assume the same values for both the direct and loss of productivity cost for both *slight* and *serious*. Therefore, the difference lies only in the intangible cost, which is the subjective cost in the Gross Output method and the actual WTP value, in the WTP method.

Using the Gross Output method, this study established the casualty cost of the *slight* category to be IDR 200,000, which is approximately 25% of a worker's monthly income and is relatively small in comparison with previous research based on secondary data. This difference was attributed to the fact that, in this study, responders were presented with the suggestion that a *slight* casualty meant that a person did not need to stay in the hospital, whilst previous studies defined a *slight* casualty as a person who was admitted for hospital treatment because of injuries that resulted from a transport related accident, but received treatment for less than 30 days. Therefore, the higher casualty cost of the *slight* category in the previous study (for example: ADB, 2009d) compared with this study was expected. The value of the *serious with no disability* is less and the *serious casualty with disability* is higher than the value of *serious* casualty in previous studies. Again, this is consistent with expectations.

3. The amount of the Intangible Cost determined from the WTP method was found to be much higher than the cost based on the Gross Output method; again, consistent with previous research. The previous study stated that the value of *slight* casualty based on the WTP method is 3.7 times greater than the Gross Output method and 3.25 greater for *serious* casualties (TRL, 1993). However, in this study the ratios were found to be much higher, at 38:1 for the *slight* casualty category and more than 5:1 for the *serious with no disability* category and more than 6:1 for *serious with disability* category. The ratio of the *slight* casualty category is so much higher than TRL (1993), reflecting the fact that the respondents were willing to pay a higher cost to avoid *slight* accident. However, it should be remembered that the definitions of '*slight*' are different and clearly, in the UK, respondents are prepared to pay more to reduce the risk of having an accident that potentially could result in a short stay in hospital. Setting aside the difference in definition of *slight* in the two studies, there may be other contributory factors to the high ratio. This could be due to the fact that in the UK individuals have more disposable income or even *'place a higher value on their lives'*.

9.3 Policy Implication

Valuing casualty cost, which is based on the WTP method which was adapted to the condition of Indonesia, as a developing country, plays an important part in this research. The casualty cost in Indonesia, published in ADB (2009a), can be considered as the most up to date information concerning the Gross Output method. The results of this study indicate that the casualty cost obtained by using the WTP method showed a considerably higher figure when compared to the results obtained from the Gross Output method (ADB, 2009a).

This indicates that losses due to accidents are higher than they were actually accounted for. Due to this, the government investments in road safety at present, based on the Gross Output method, are somewhat lower than what is actually required. The results obtained from this study are expected to make a significant contribution when it comes to updating cost figures for slight and serious casualties generated by motorcycle accidents. This will potentially lead to decisive future investment decisions on road safety in Indonesia, in particular, and developing countries, in general.

9.4 Limitations of the Study

This research has several limitations, described as follows.

1. The study is based on the primary data gained from motorcyclists, or people who use other modes in the system, who have experienced an accident involving motorcycles. As a consequence of this, it was very difficult to find respondents who had experiences with serious injuries in either the non-disabled or disabled categories. On the other hand, time and money resources available for the study were significantly constrained and, therefore, the number of samples collected for the serious injury category was limited. Due to the reasons explained above, the model estimated for the serious injury category did not provide significant results.
2. The methodology used for questionnaire design, particularly for the SP choice experiment, was based on changing “brake pads”, as motorcyclists in

Surabaya are reluctant to change brake pads until they are in an extremely bad condition, even though well maintained brake pads are crucial as far as safety is concerned. It is possible that motorcyclists in other developing counties may act differently on the issue of changing brake pads. For this reason, applicability of changing "brake pad" for designing the SP questionnaire in this study to other countries might be questionable.

3. Difficulties have arisen when attempting to compare the results of this research with previous studies, mainly because the definitions of the casualty categories vary between a range of studies. In this study, *slight* casualty is a person who suffered with minor injuries and did not require medical treatment in hospital as in-patients. While previous studies define slight casualty as a person who suffered minor injuries and was treated in hospital for less than 30 days. In this study, serious injury is divided into two categories, serious with no disability and serious with disabitliy; whereas previous studies only employ one category, serious only. Integrating two classes into one may not be ideal when presenting the severity of the casualty. Even though this is not recognised as a major limitation, the outputs of this study cannot be easily compared with previous studies.

9.5 Recommendations for Further Research

Recommendations for further research are proposed as follow:

- The SP model here has been shown to be a very useful tool for the purpose of developing an understanding of the perceived value that an individual places on the cost of avoiding a motorcyclist casualty. However, to ensure that there is no bias introduced in the responses to the questions the interviewer must maintain consistency. This makes the administration of the survey difficult, especially if there is more than one interviewer carrying out the surveys. For this reason, all the interviews were conducted by the author. The SP technique is labour intensive and the interviews took between 10 and 20 minutes; sometimes even longer when preview information was taken into consideration. Consequently, this limited the number of questionnaires. Any future SP survey of similar length to this one should have a much larger sample in order to maintain statistical significance at a 95% level for all variables such as the number of children. In addition, further research could address other modes of transport such as car, heavy vehicle and bicycle.

- The results of this study have provided a base for independently modelling the subjective cost of motorcyclist casualty in developing countries and in particular Indonesia. This study goes a step further to assert the importance of variables that influence the subjective cost of casualty, these being income and age. The influence of the number of children on the value placed on a casualty was inconclusive at a 95% level of confidence which could be rectified by increasing the total number of interviews. In the future, there is potential to explore the influence of other variables such as the level of experience in driving a motorcycle, whether the rider enjoys the experience of riding a motor cycle or the ownership of other vehicles. However, further complications arise with each additional question that is posed and could extend, to the point of impracticality, the duration of what already is a lengthy survey.

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Section I: severities classes

Picture	Description	Not serious	Serious but death worse	As bad as death	Slightly worse than death	Much worse than death	Very much worse than death	No Answer
	Cut and bruised but can leave hospital after a couple of days and recover fully within a month							
	Break an arm							
	In hospital for a year, but recover fully							
	Loose a leg							
	Loose an eye							
	Badly scarred for life and in hospital for a year							
	Confined to wheelchair for the rest of your lif							
	Permanently bed-ridden							

Section II: General enquiry

1	Address	:	
2	Sex	:	
3	Age	:	
4	Education		
5	Daily mode transport used	:	
6	Have you got motor cycle accident		Yes / No
7	If "No" go to question 11		
8	When it happened (month-year)		
9	What your position		Driv / Pillion / Pedestria
10	How was your severity class		Slight / SBND / SWD
11	Are you self supporting	:	Yes / No
12	Have you been married		Yes / No
13	**If 11 = yes and 12 = no go to question 25**		
14	**If 11 = no and 12 = yes go to question 34**		
15	**If 11 = no and 12 = no go to question 42**		
16	Occupation *		
17	Monthly income (Rp)		
18	Spouse' s occupation		
19	Spouse's monthly income (Rp)		
20	No of children and dependent		
21	Family's monthly expenses (Rp)		
a	Transport cost (including fuel if any)		
b	Communication/mobile		
c	Electricity		
d	Water		
e	Mortgage (for house or others)		
f	Food		
g	Entertainments		
h	Cloths		
i	Books		
j	Others (please stated if possible)		

22	Can you save your income		Yes No
23	If “Yes”, please stated the amount (Rp)		
24	How many motorcycles and cars do you have		and
	If you are self support and have married, you may terminate **Many thanks for your participation**		
25	Occupation *		
26	Monthly income (Rp)		
27	Monthly expenses (Rp)		
a	Transport cost (including fuel if any)		
b	Communication/mobile		
c	Electricity		
d	Water		
e	Mortgage (for house or others)		
f	Food		
g	Entertainments		
h	Cloths		
i	Books		
j	Others (please stated if possible)		
28	How many motorcycles and cars do you have		and
29	How many brothers and sisters you have		
30	How many brothers and sisters are studying		
31	What your parents occupation		and
32	Can you save your income		Yes No
33	If “Yes”, please stated the amount (Rp)		
	If you are self support and haven’t married yet, you may terminate **Many thanks for your participation**		
34	Occupation		
35	Spouse’ s occupation		
36	Spouse’s monthly income (Rp)		
37	No of children and dependent		
38	Family’s monthly expenses (Rp)		
a	Transport cost (including fuel if any)		

b	Communication/mobile		
c	Electricity		
d	Water		
e	Mortgage (for house or others)		
f	Food		
g	Entertainments		
h	Cloths		
i	Books		
j	Others (please stated if possible)		
39	Can you save your income		Yes No
40	If “Yes”, please stated the amount (Rp)		
41	How many motorcycles and cars do you have		and
	If you are not self support and have married, you may terminate **Many thanks for your participation**		
42	Occupation		
43	Monthly pocket money (Rp)		

Section III: WTP's questionnaire

Card WTP 1		
Criteria	Option A	Option B
Maximum possible speed (km/hr)	70	60
Change brake pad in every (km)	7.500	8.000,00
Probability get serious with permanet disability	3 in 100,000	4 in 100,000
Additional cost (Rp.)	3.000	0
Which alternative do you prefer?	☐	☐
What will you give up to pay for it		

Card WTP 2		
Criteria	Option A	Option B
Maximum possible speed (km/hr)	70	60
Change brake pad in every (km)	7.000	8.000
Probability get serious with permanet disability	2 in 100,000	4 in 100,000
Additional cost (Rp.)	5.900	0
Which alternative do you prefer?	☐	☐
What will you give up to pay for it		

Card WTP 3		
Criteria	Option A	Option B
Maximum possible speed (km/hr)	70	60
Change brake pad in every (km)	7.600	8.000,00
Probability get serious but no permanet disability	7 in 100,000	10 in 100,000
Additional cost (Rp.)	2.500	0
Which alternative do you prefer?	☐	☐
What will you give up to pay for it		

Card WTP 4		
Criteria	Option A	Option B
Maximum possible speed (km/hr)	70	60
Change brake pad in every (km)	7.300	8.000
Probability get serious but no permanet disability	5 in 100,000	10 in 100,000
Additional cost (Rp.)	4.200	0
Which alternative do you prefer?	☐	☐
What will you give up to pay for it		

Card WTP 5		
Criteria	Option A	Option B
Maximum possible speed (km/hr)	70	60
Change brake pad in every (km)	7.880	8.000,00
Probability get slight injury	20 in 100,000	27 in 100,000
Additional cost (Rp.)	700	0
Which alternative do you prefer?	☐	☐
What will you give up to pay for it		

Card WTP 6		
Criteria	Option A	Option B
Maximum possible speed (km/hr)	70	60
Change brake pad in every (km)	7.790	8.000
Probability get slight injury	13 in 100,000	27 in 100,000
Additional cost (Rp.)	1.300	0
Which alternative do you prefer?	☐	☐
What will you give up to pay for it		

Card WTP 7			
Criteria	Option A	Option B	Option C
Maximum possible speed (km/hr)	60	70	70
Change brake pad in every (km)	8.000	7.500	7.000
Probability get serious with permanet disability	4 in 100,000	3 in 100,000	2 in 100,000
Additional cost (Rp.)	0	3.000	5.900
Which alternative do you prefer	☐	☐	☐
What will you give up to pay for it			

Card WTP 8			
Criteria	Option A	Option B	Option C
Maximum possible speed (km/hr)	60	70	70
Change brake pad in every (km)	8.000	7.600	7.300
Probability get serious but no permanet disability	10 in 100,000	7 in 100,000	5 in 100,000
Additional cost (Rp.)	0	2.500	4.200
Which alternative do you prefer	☐	☐	☐
What will you give up to pay for it			

Card WTP 9			
Criteria	Option A	Option B	Option C
Maximum possible speed (km/hr)	60	70	70
Change brake pad in every (km)	8.000	7.880	7.790
Probability get slight injury	27 in 100,000	20 in 100,000	13 in 100,000
Additional cost (Rp.)	0	700	1.300
Which alternative do you prefer	☐	☐	☐
What will you give up to pay for it			