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Study on Motorcycle Crash Cost in Bandung City

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Abstract

Crash cost is an important component for conducting economic analysis in selecting countermeasures for crash locations. It is used to convert the benefit of crash or fatality reduction into monetary terms. Many research on crash cost have been carried out in Indonesia. Most of the research utilized gross output/human capital approach. However, this approach has been widely criticized for not being able to describe the quality of life of crash casualties and the costs of pain, grief and suffering (i.e. human cost). The concept of Value of Statistical Life (VoSL) has been introduced by InDeV (2016) to calculate the human cost, which is assessed by using willingness to pay approach. To obtain a more reliable estimation of crash cost for Indonesia, it is necessary to conduct a study on crash cost involving motorcycles which incorporates the estimation of human cost. The VoSL is obtained by interviewing motorcycle users for willingness to pay with safety equipment. Based on the analysis, it is obtained that the value of statistical life (VoSL) for fatality in a road crash was estimated to be Rp.2.3 billion. The unit cost of fatal injury is Rp.3.08 billion, serious injury is Rp.333 million and slight injury is Rp.24.9 million. The unit cost of fatal crash on arterial roads is Rp.3.23 billion, serious crash is Rp.451 million and the slight crash is Rp.114 million. The unit cost of fatal crash on collector roads is Rp.3.16 billion, serious crashes is Rp.381 million and minor crash is Rp.69.4 million. The unit cost of fatal crash on local roads is Rp.3.09 billion, serious crash is Rp.338 million, and minor crash is Rp.29.8 million.

Keywords: Motorcycle crash cost, gross output approach, human capital approach, willingness to pay approach

Abstrak

Biaya kecelakaan merupakan komponen penting untuk melakukan analisis ekonomi dalam memilih jenis penanganan lokasi rawan kecelakaan. Biaya kecelakaan digunakan untuk mengkonversi keuntungan dari pengurangan kecelakaan kedalam nilai moneter. Beberapa penelitian mengenai biaya kecelakaan telah dilakukan di Indonesia. Sebagian besar penelitian yang dilakukan menggunakan pendekatan gross output/ human capital. Namun, pendekatan ini telah banyak dikritik karena tidak dapat menggambarkan kualitas hidup korban kecelakaan dan biaya rasa sakit, kesedihan dan penderitaan (biaya manusia/human cost). Konsep Value of Statistical Life (VoSL) telah diperkenalkan oleh InDeV (2016) untuk menghitung biaya manusia, yang dinilai menggunakan pendekatan kesediaan membayar. Dalam mendapatkan estimasi biaya kecelakaan yang lebih akurat di Indonesia, perlu dilakukan studi tentang biaya kecelakaan yang melibatkan sepeda motor yang mencakup estimasi biaya manusia (human cost). Besarnya nilai VoSL diperoleh dengan melakukan wawancara terhadap pengguna sepeda motor berapa kesediaan membayar lebih dengan skenario peralatan keselamatan. Berdasarkan analisis, diperoleh bahwa nilai kehidupan statistik (VoSL) untuk korban meninggal dunia dalam kecelakaan di jalan diperkirakan mencapai Rp.2,3 miliar. Biaya satuan kecelakaan korban meninggal dunia adalah Rp.3,08 miliar, luka serius Rp.333 juta dan luka ringan Rp.24,9 juta. Biaya satuan kecelakaan fatal di jalan arteri adalah Rp.3,23 miliar, kecelakaan serius adalah Rp.451 juta dan kecelakaan ringan adalah Rp.114 juta. Biaya satuan kecelakaan fatal di jalan kolektor adalah Rp.3,16 miliar, kecelakaan serius adalah Rp.381 juta dan kecelakaan ringan adalah Rp.69,4 juta. Biaya satuan kecelakaan fatal di jalan lokal adalah Rp.3,09 miliar, kecelakaan serius adalah Rp.338 juta, dan kecelakaan ringan adalah Rp.29,8 juta

Kata kunci: Biaya kecelakaan sepeda motor, pendekatan gross output, pendekatan human capital, pendekatan kesediaan membayar.

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1. Introduction

Crash cost is an important component for conducting economic analysis in selecting countermeasures for crash locations. It is used to convert the benefit of crash or fatality reduction into monetary terms. Methods to calculate crash cost has been widely available. The more common ones including human capital approach (e.g. Ahadi & Razi-ardakani, 2015 and Thuy Anh et al., 2005) and willingness to pay approach (e.g. Le et al., 2011 and Mohd Fauzi et al., 2006). The human capital approach calculates crash cost as the sum of direct crash-related costs plus the loss of productivity cost experienced by the crash casualties. Meanwhile, the willingness to pay approach for calculating crash cost is based on the amount of money people will pay to avoid or to reduce the risk being involved in a crash.

Many research on crash cost have been carried out in Indonesia. Widyastuti et al (2005) analyzed willingness to pay of motorcycle riders in Surabaya to reduce the risk of slight injury in a motorcycle crash. Other research were mostly based on the gross output/ human capital approach; e.g. research by Jefrizon and Malkhamah (2004), Departemen Pekerjaan Umum (2005), Meydita (2013), Widyopratito (2014), and Sugiyanto et al (2016). However, this approach has been widely criticized for not being able to describe the quality of life of crash casualties and the costs of pain, grief and suffering (i.e. human cost). Human costs are the immaterial costs of lost quality of life and lost life years and are one of the main cost components. To alleviate this, InDeV (2016) developed the concept of Value of Statistical Life (VoSL) to calculate the human cost, which is assessed by using willingness to pay approach. This approach is used to estimate the economic value of lost years of life and lost quality of life as there is no market price for this impact.

The value of statistical life (VoSL) is based on economic welfare theory. It reflects the strength of community preference measured from the maximum amount that individuals are willing to pay to reduce the risk of fatality/injury from a crash (Covey et al, 2009). The concept of VoSL has actually been long studied. For example, Lanoie, P., Pedro, C. and Latour (1995) studied the VoSL in Montreal, Canada by using revealed preference method and contingent valuation method. Miller (2000) examined VoSLs from 68 studies in 13 countries and found that the VoSL was typically about 120 times GDP per capita. Blaeij et al (2003) conducted a meta-analysis study to determine variables that influence variation of different VoSL results over countries. In Asia region, Mohd Fauzi et al (2006) used willingness to pay approach to estimate VoSL of motorcycle users in Malaysia. Tjahjono & Hendratmoko (2014) calculated VoSL of Jagorawi Toll road users using willingness to pay approach by applying two proxy measures, i.e. vehicle maintenance and health maintenance. However, none of them has utilized the VoSL for calculating the human cost.

To obtain a more reliable estimation of crash cost for Indonesia, it is necessary to conduct a study on crash cost which incorporates the estimation of human cost. In this case, Bandung city was selected as the study area. Since more than half of traffic crashes occurred in Bandung involved motorcycle users Bandung City Government (2018), this study focused on calculating crash cost involving motorcycle in Bandung based on method proposed by InDeV (2016) where the human cost will be estimated using the VoSL obtained from willingness to pay survey.

2. Research Methodology

InDeV (2016) classifies crash cost components into costs per casualty and costs per crash. Costs per casualty consists of medical cost, production loss cost, human cost, funeral cost, and cost for accompanying the casualties in hospital. Costs per crash is divided into property damage cost, administrative cost, and congestion cost.

Medical costs are defined as the costs related to medical treatment of road casualties. They are obtained from hospital medical record data. Medical costs may include first aid transportation cost from crash scene to hospital, emergency unit cost, in-patient hospital treatment cost, out-patient hospital treatment cost, non-hospital treatment costs (e.g. rehabilitation cost, general practitioner cost, physiotherapy cost, home care cost, etc.), as well as aids and appliances cost.

Production loss cost is defined as the potential loss of income of a road casualty as a result of crash. The loss of income can be permanent (if the person is death or seriously injured) or temporary (if the person can recover from the crash). In this study, the production loss for fatal casualty is calculated as the average income of the fatal casualty projected to the end of casualty's productive age of 60 years and converted into present value. The production loss for seriously injured casualty is estimated based on the length of days the casualty cannot work as a result of crash (i.e. 66 days) and the length of days the casualty waited for a new job after recovering from the crash (i.e. 22 days). The production loss of the slightly injured casualty is calculated based on the the length of days the casualty does not work to recover from the crash (i.e. 2 days).

Human costs are intangible costs, which consist of the costs of pain, grief, sorrow and loss of quality of life. Human costs of fatality is due to lost life years while human costs of injury is due to loss of quality of life. Wismans (2017) stated that double counting can occur when adding VoSL into the crash cost. VoSL consists of human costs plus future consumption that will occur if a person does not die (i.e. consumption loss). Nevertheless, consumption loss is also part of the productivity loss calculated by the Human Capital method (i.e. gross production loss). Reducing the future consumption loss from gross production costs resulted in net production loss. Therefore, the human costs are estimated by subtracting the VoSL with loss of future consumption due to crash.

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In this study the value of VoSL was obtained by using willingness to pay approach that VoSL is estimated based on the amount of money individuals are willing to pay to reduce fatality/injury risk (WTP). In the questionnaire, respondents were asked to choose one of three options regarding proxy on helmet wearing:

- Option A: use standardized (SNI) helmet and routinely change it every 3 years. By selecting this option, fatality risk will reduce by 40%.
- Option B: use standardized (SNI) helmet but not routinely change it every 3 years. By selecting this option, fatality risk will reduce by 30%.
- Option C: use a non-standardized (SNI) helmet. By selecting this option, fatality risk will reduce by 20%.

The VoSL for each options are calculated as follows:

$$VoSL_{option\ i} = \frac{WTP_{option\ i}\ x\ motorcycle\ population}{Lives\ saved} \quad (1)$$

Furthermore, the calculated VoSL values for fatal casualty are weighted using percentage of respondents selecting each options to represent the condition of the entire population. The resulting VoSL per person is the total weighted VoSL for Option A, Option B, and Option C.

According to Bickel. et al. (2006), if a country does not have a specific estimate of human costs for serious injury and minor injury casualties, they can use a value available from another country. European standard value of VOSL for serious injury is 13% of VoSL fatal casualty and for minor injury is 1% of VoSL fatal casualty.

Property damage costs include motorcycles damage cost and infrastructure damage cost. Administrative costs may consist of police operation costs, fire department costs, insurances administration costs, and legal costs. Congestion cost is the loss of time incurred due to crashes. The congestion cost is obtained from the value of lost time during the delay incurred by a crash multiplied by the number of traffic that are passing through the road in which the crash occurred.

The unit cost of fatal crash is obtained by multiplying the typical number of fatal/serious injury/slight injury casualties incurred from a fatal crash with the respective unit cost of fatal/serious injury/slight injury casualties plus costs per fatal crash (property damage cost, administrative cost, and congestion cost).

The unit cost of serious crash is obtained by multiplying the typical number of serious injury/slight injury casualties incurred from a serious crash with the respective unit cost of serious injury/slight injury casualties plus costs per serious crash (property damage cost, administrative cost, and congestion cost).

The unit cost of minor crash is obtained by multiplying the typical number of slight injury casualties incurred from a minor crash with the respective unit cost of slight injury casualties plus costs per minor crash (property damage cost, administrative cost, and congestion cost).

The crash costs were then calculated for arterial road, collector road, and local road.

3. Data

3.1 Casualty data

The research study is in Bandung City, West Java Province, Indonesia. Data Traffic Accidents in Bandung City during 2016-2018 were obtained from Bandung Police and Medical costs were obtained from the Hasan Sadikin Hospital. The analysis of crash casualty data shows that the average age of fatal casualty is 38 years, serious injury casualty is 26 years, and slight injury casualty is 29 years. The typical casualty composition in a fatal crash is 1 person died, a serious injury crash is 1 seriously injured person, and a slight injury crash is 1 slightly injured person.

The amount of VoSL costs and loss of consumption based on interviews with 100 motorcycle users using the willingness to pay survey. The duration of time a seriously injured casualty cannot work based on an interview with 15 respondents seriously injured is 66 days and the wait for a new job is 22 days. Meanwhile, the duration of time a slightly injured casualty cannot work is 2 days based on medical data duration treatment for slightly injured 1 day and 1 day of rest at home

3.2 Crash cost data

3.2.1 Costs per casualty data

Medical costs were obtained from medical record data for fatal, serious injury and minor injury casualties. The average costs are Rp.4,928,000 for fatal casualty, Rp.12,609,800 for serious injury casualty, and Rp.1,229,059 for slight injury casualty.

Production lost cost for fatal casualty was estimated based on Bandung people's average income of Rp.52,295,354 per year with a yearly increase of 8.48% and inflation of 3.51% per year. Thus, the production lost cost for fatal casualty is obtained to be Rp.2,060,750,490. Production lost cost for serious injured casualty is Rp.18,776,667 and for slight injury casualty is Rp.421,007.

The willingness to pay survey was conducted by interviewing 100 respondents. The result is that as many as 40% of respondents chose Option A, 56% of respondents chose Option B, and 4% of respondents chose Option C. The average willingness to pay for option A is Rp.98,250, option B is Rp.59,107 and option C is Rp.35,000. The number of motorcycle users is 1,328,783 people. The number of annual fatalities in 2018 is 123 person.

The VoSL are then calculated by using Eq.1, and it is obtained that VoSL for Option A is Rp.2,611,000,000, for Option B is Rp.2,122,000,000 and for Option C is Rp.1,860,000,000. The weighted VoSL for Option A is Rp.1,044,000,000, for Option B is 1,188,000,000 and for Option C is Rp.74,410,000. So that the resulting VoSL for fatal casualty is Rp.2,307,000,000 per person.

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The human cost for fatal casualty is then calculated by subtracting VoSL with loss of future consumption. The loss of consumption for the remaining 22 productive years is estimated to be Rp.1,288,323,230. Loss of consumption is obtained from average consumption in 2019 which is projected to 2018 by considering the inflation rate. Therefore, the human cost for fatal casualty is Rp.1,019,234,145. The human cost for serious injury casualty is Rp.299,982,459 (13% of VoSL fatal casualty) and that for slight injury casualty is Rp.23,075,574 (1% of VoSL fatal casualty).

Costs for family member attending a crash casualty at hospital are estimated as Rp.895,402 for fatal casualty, Rp.1,790,804 for serious injury casualty, and Rp.179,080 for slight injury casualty. The funeral cost is Rp.427,500.

3.2.2 Costs per crash data

The property damage costs due to a crash were obtained from police reports for each crash severities. The property damage cost for fatal crashes is Rp.1,834,749, for serious injury crashes is Rp.1,020,000, and for slight injury crashes is Rp.1,649,857.

There are no administrative costs of police as it is borne by the government. The congestion costs are differentiated by the type of roads: arterial, local, and collector roads. In this research, a case study of arterial roads on Jalan Ahmad Yani, collector roads on Jalan Buah Batu and local roads on Jalan Manisi Cibiru were taken. For arterial roads, the congestion costs are found to be Rp.146,137,167 for fatal crashes, Rp.116,909,733 for serious injury crashes, and Rp.87,682,300 for slight injury crashes. For collector roads, the congestion costs are Rp.76,337,079 for fatal crashes, Rp.47,710,674 for serious injury crashes, and Rp. 42,939,607 for slight injury crashes. For local roads, the congestion costs are Rp.4,729,242 for fatal crashes, Rp.4,256,318 for serious injury crashes, and Rp.3,310,469 for slight injury crashes.

4. Crash Cost Calculation

4.1 Unit cost of casualty

Table 1 presents summary of crash casualty cost components based on crash severity. The table also shows the calculated unit cost of fatal, serious injury, and slight injury casualties are Rp.3,086,235,536, Rp.333,159,730, and Rp.24,904,719, respectively.

4.2 Unit cost of crash

Unit cost of crash is calculated based on crash severity for crashes occur in arterial, collector, and local roads, as presented in **Table 2**.

5. Analysis

Figures 1, **2**, and **3** describes the proportion of crash cost component in arterial road, collector road, and local road for fatal crashes, serious injury crashes, and slight injury crashes, respectively.

Table 1. Unit cost of casualty

Cost per Casualty Component	Crash Severity		
	Fatal	Serious Injury	Slight Injury
Medical Cost	4,928,000	12,609,800	1,229,059
Production Loss	2,060,750,490	18,776,667	421,007
Human Cost	1,019,234,145	299,982,459	23,075,574
Attending Casualty at Hospital	895,402	1,790,804	179,080
Funeral Cost	427,500	-	-
Unit Cost of Casualty	**3,086,235,536**	**333,159,730**	**24,904,719**

Table 2. Unit cost of crash in arterial road

Crash Cost Component	Fatal Crash	Serious Injury Crash	Slight Injury Crash
Cost of Casualty	3,086,235,536	333,159,730	24,904,719
Congestion Cost in Arterial Road	146,137,167	116,909,733	87,682,300
Congestion Cost in Collector Road	76,337,079	47,710,674	42,939,607
Congestion Cost in Local Road	4,729,242	4,256,318	3,310,469
Unit Cost of Crash in Arterial Road	3,234,207,452	451,089,463	114,236,876
Unit Cost of Crash in Collector Road	3,164,407,365	381,890,404	69,494,183
Unit Cost of Crash in Local Road	3,092,799,527	338,436,047	29,865,045

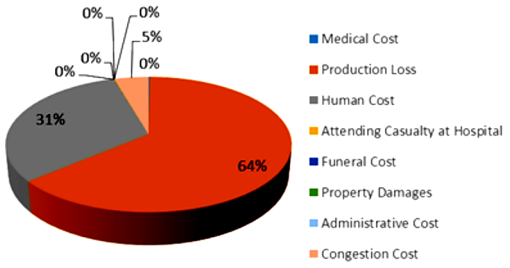

Figure 1. Fatal crash cost component proportion in arterial road

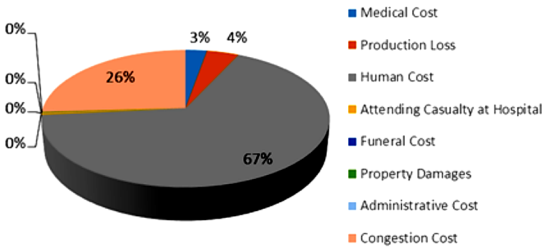

Figure 2. Serious Injury Crash Cost Component Proportion in Arterial Road

It can be seen from those figures that the biggest proportion of fatal crash cost occurring on arterial roads is the lost productivity cost (63.72%) because fatal casualties will lose income until the retirement age of 60 years. Meanwhile, the human cost contributes to 66.5% of serious injury crash costs on the arterial roads because serious casualties may lose their jobs due to disabilities and have to find new jobs.

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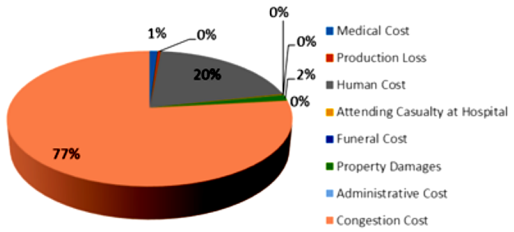

Figure 3. Slight Injury crash cost component proportion in arterial road

For slight injury crashes, the biggest component of crash cost is the congestion cost (76,75%) because on the arterial road the traffic volumes can be relatively high. If an accident occurs, the delay time due to the accident is longer than the collector road and local road, so it is difficult to control traffic.

The unit cost component of crashes that occur on collector and local roads differs only in congestion costs. **Figure 4** shows the comparison of congestion costs due to crashes that occur on arterial, collector and local roads.

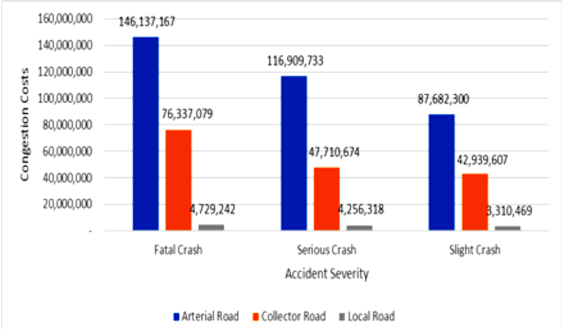

Figure 4. Comparison of congestion cost in arterial, collector, and local roads

The highest congestion cost is on arterial roads because higher flow passes through the road as compared to collector and local roads, resulting in longer delay due to crashes.

When compared to the study by Widyopratito (2014), the unit cost of slight injury involving motorcycle crashes in Bandung city is Rp.697,928.28. The value is obtained based on 2012 data using human capital approach. After converted into 2018 value, the unit cost is Rp.858,553.93. That value is only 2.8% of the value obtained in this study for the same category. The huge difference is due to the assumption of human cost used by Widyopratito (2014), that human cost was taken as 8% of the total direct crash cost.

6. Conclusion and Recommendation

1. The willingness to pay approach in this study uses the VoSL concept introduced by InDeV (2016) because it describes the quality of life of crash casualties and the costs of pain, grief and suffering (human costs).
2. This study concludes that the unit cost of traffic crashes involving motorcycles on arterial roads in Bandung City for fatal crash is Rp.3,234,207,452, for serious crash Rp.451,089,463, and for minor crash Rp.114,236,876. On collector roads, the unit cost of fatal crash is Rp.3,164,407,365, serious crash Rp.381,890,404, and minor crash Rp.69,494,183. The unit cost of fatal crash on local roads for fatal crash is Rp.3,092,799,527, for serious crashes is Rp.338,436,047, and for minor crash is Rp.29,865,045.
3. The unit cost of fatal casualty in a motorcycle crash is Rp.3,086,235,536, serious injury casualty is Rp.333,159,730 and slight injury casualty Rp.24,904,719. The VoSL of a fatal casualty is Rp.2,307,557,375 per person.
4. Crash cost is used for conducting economic analysis in selecting countermeasures for crash locations. It is used to convert the benefit of crash or fatality reduction into monetary terms.

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