Jurnal Teknologi

Full Paper

ROAD TRAFFIC ACCIDENT COST USING HUMAN CAPITAL METHOD (CASE STUDY IN PURBALINGGA, CENTRAL JAVA, INDONESIA)

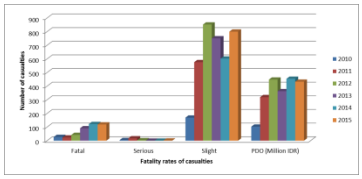
Gito Sugiyanto[a*], Mina Yumei Santi[b]

[a]Civil Engineering Department, Faculty of Engineering, Jenderal Soedirman University. Jln. Mayjend. Sungkono, km.5, Blater, Kalimanah, Purbalingga, Central Java, Postcode 53371, Indonesia
[b]Health Polytechnic of Yogyakarta, Jln. Mangkuyudan MJ III/304 Yogyakarta Postcode 55143, Indonesia

Article history
Received
2 September 2015
Received in revised form
3 January 2017
Accepted
15 January 2017

*Corresponding author
gito_98@yahoo.com

Graphical abstract



Abstract

Basic principles of transportation are safety and security, efficiency and equity. The traffic accident rate in Indonesia is still considerably high. In 2014 as reported by the national police, with around 263 accidents per day. Of reported casualties per day, 77.5 people are fatalities, 73.5 people are serious injuries, and 301 people are slightly injuries. Total of the Property Damage Only (PDO) is IDR250,110,380,000 (US$18.547 million). To estimate the economic impacts of accidents, the number of accident casualties and accident costs are the most needed data. The aims of this study is to analysis traffic accidents cost using Human Capital Method. The research location in Purbalingga, Central Java, Indonesia using data from 2010-2015. The accident cost analysis based on the casualty severity of accidents is fatal, seriously injured, slightly injured, and PDO. Components of accident costs include costs to repair vehicle, administrative cost, medical care, and potential loss of human productivity, and human cost. Casualty accident costs by severity type: fatality is IDR501,210,320 (US$37,168), serious injury is IDR18,874,950 (US$1,400), slight injury is IDR6,255,708 (US$464), and property damage only is IDR3,047,914 (US$226). Total accident cost in Purbalingga was estimated IDR236,517,103,652 (US$17,539,274) or 1.27% of the gross domestic product.

Keywords: Traffic accidents, accident cost, human capital method, safety

1.0 INTRODUCTION

Basic principles of transportation are safety and security, efficiency, and equity. The traffic accident rate in Indonesia is still considerably high, as reported by the national police and Ministry of Transportation, in 2014 was recorded 95,906 cases (around 263 accidents per day) that resulted in 28,297 people died (around 77.5 people are fatalities per day), 26,840 people suffered serious injuries (around 73.5 people are serious injuries per day), 109,741 people suffered slightly injuries (around 301 people are slightly injuries per day) [1]. Total of the Property Damage Only (PDO) is IDR250,110,380,000 (US$18.547 million) [2].

The majority cause of the accident in Indonesia was men and the majority of vehicles are motorcycles. The highest accident causal is the human error factor [3]. Global Road Safety Partnership (GRSP) is a partnership between business, civil society, and government dedicated to the sustainable reduction of death and injury on the roads in developing and transition countries. The aim is to increase awareness of road safety [4]. According to insurance reports, about 187 transportation-related casualties are recorded each day, with 63 of these being fatalities. However, Sutomo suggests that traffic accident data are definitely underreported [5]. To estimate the economic impacts of accidents, number of accident casualties and accident costs are the most needed data [6].

There are six methods that can be used to analyze the cost of accidents to estimate how much the losses caused by traffic accidents [7, 8]. While, Anh *et al*. states there are seven methods, namely: gross output method, human capital method, net output method, Life insurance method, court-award method, implicit public sector valuation method, and willingness to pay method [9]. Hills and Jones-Lee identified six different methods that have been proposed for placing a cost on road accidents [7]. All of the methods outlined were applicable to non-fatal as well as to fatal accidents but for reasons of clarity and simplicity, they concentrated on describing accidents involving one fatality only [10]. Gross output method suited to the objective of maximizing the wealth of a country. Willingness to pay method for social welfare maximization and use in cost benefit analysis [10].

Some approaches are used to estimate the economic impacts of traffic accidents. According to Miller [11], two general approaches exist to quantify human safety: the human capital method and the comprehensive method. The human capital method calculates the direct cost of accidents, such as related vehicle repair costs, necessary medical treatment costs, and related loss of productivity costs. The comprehensive method basically estimates the insurance costs, which reflect the compensation for individuals who are trying to anticipate the negative impacts of accidents [11]

Human capital method combines the costs that occur during and after traffic accidents. The costs consist of administrative costs, related vehicle repair costs, medical treatment costs, and present value estimates of accident victims' loss of income due to accidents. This method is also called gross output method. To estimate the economic value of output loss, average assumption is used because accidents could take place randomly, at any income level. This approach is valid for computing aggregate costs at the national level. However, the cost of individual cases at each injury level could vary dramatically [6].

Traffic accidents cause a very high cost but it is often forgotten by road user [12]. In Indonesia, by the Director of Land Transport Safety estimated the losses as a result of the accident in 2002 at IDR41.4 trillion (approximately US$4.5 billion) [13] or 2.9% of the gross domestic product (IDR1,421 trillion) [6]. In Jordan, traffic accidents cost in 1996 around JD103 million ($US146.3 million) [14]. In Australia, accidents cost in 2003 approximately AUS$17 billion (2.3% of Gross National Income Australia) [15]. In Singapore, the total of traffic accidents cost occurring in 2003 is S$610.3 million about 0.338% of the gross domestic product or GDP [16]. Total of traffic accident costs in Thailand in 2004 are estimated at 153,755 million baht (US$3,460 million) [17].

The aims of this study are to analysis the traffic accidents cost using human capital method by severity type and to estimate the total accident cost in Purbalingga District.

2.0 METHODOLOGY

2.1 The Study Location

The study location is in Purbalingga Regency, Central Java Province, Indonesia. The location of study can be seen in Figure 1.

Figure 1 Location of study in Purbalingga, Central Java [18]

2.2 Data Collection

Traffic accident data, vehicles involved in traffic accident, identity and address the casualties of traffic accidents obtained from Purbalingga Police sourced from Data Traffic Accidents in Purbalingga during 2010-2015 [19] and the hospital in Purbalingga. Component cost of accidents in this study were divided into two, namely direct costs and indirect costs. Direct costs include: costs of property damage, medical expenses, administrative expenses, and loss of productivity. The amount of direct costs based on the fatality rate of casualties obtained based on interviews with 25 the casualties of PDO, 30 casualties of slightly accidents, 20 casualties of serious accidents, and 25 families of casualties of fatal accidents. The total respondent is 100 peoples.

2.3 Analysis of Accident Cost

Each component of traffic accidents cost is analyzed using human capital method according to Silcock and Transport Research Laboratory [20] and Asian Development Bank [6]. The traffic accident cost is analyzed based on casualty cost by severity type. In this study classifies casualty severity based on Law 14, 1992 (Traffic and Land Transport) [21]. Casualty severity is classified in three categories: fatal, seriously injured, and slightly injured. Based on Law 22, which was enacted in 2009 (Traffic and Land Transport), traffic accident is classified in three categories, fatal accidents, serious accidents, and slightly accidents [22]. A damage-only accident or property damage

only (PDO) is one in which no one is injured but damage to vehicles and or property is sustained [10].

According to the Transport Research Laboratory, traffic accidents cost components are grouped into two categories, namely direct costs and indirect costs. Indirect costs are a percentage of direct costs. Direct costs component of traffic accidents includes property damage, administrative costs, medical costs, and loss of productivity [10].

a) Property damage
   In each accident there is some amount of damage to vehicles and property damage on a side street [20].
b) Administrative costs
   Police costs and costs incurred for the funeral for the victims' family died also included in administrative costs [20].
c) Medical costs
   Medical expenses for injuries is the cost since the occurrence of the accident until the time of healing, or for deaths, including the cost of first aid, ambulance, hospital costs (food, room, surgery, and medicine) and the cost of healing or rehabilitation [20].
d) Loss of productivity
   Loss of productivity is often associated with a loss of economic value to work because of an accident. The amount of working time lost for the casualties is died was the time they spent into future if they do not die multiplied with the income of casualty [20]. For the casualties is died, loss of productivity is calculated based on the amount of productive age expectations set 60 (sixty) years. For seriously injured and slightly injured lost productivity is calculated as the length of time they cannot work multiplied by the income of casualty if they works. In property damage only, the loss of productivity is 0.

Having obtained the direct costs, the next step is calculating the indirect costs. Indirect costs include: the cost of pain, grief, and suffering. The amount of indirect costs as the percentage of direct costs of 28% for fatal accidents, 50% of serious accidents, 8% for the slightly accidents of the total direct cost [20]. Based on the results of the analysis of direct costs and indirect costs, subsequently summed to determine the casualty cost of accident by the severity type.

3.0 RESULTS AND DISCUSSION

3.1 Traffic Accident in Purbalingga

Based on the analysis of traffic accident data from Purbalingga Police during 2010-2015 occurred 2314 accidents with the fatality of casualties is 424 fatal (27 peoples died in 2010, 23 peoples died in 2011, 42 peoples died in 2012, 91 peoples died in 2013, 122 peoples died in 2014, and 119 peoples died in 2015). During 2010-2015, there are 25 peoples have serious injured (4 in 2010, 17 in 2011, 3 in 2012, and 1 in 2015). There are 3750 people have slightly injured (169 in 2010, 576 in 2011, 852 in 2012, 751 in 2013, 602 in 2014, and 800 in 2015). Total of the Property Damage Only (PDO) in Purbalingga Regency, Central Java, Indonesia during 2010-2015 is IDR2,067,550,000 (US$153,322). In 2015, occurred 548 accidents (23.68% of total accident case) as the highest value during 2010-2015. The fatality rates of traffic accident casualties in Purbalingga during 2010-2015 as shown in Figure 2 below.

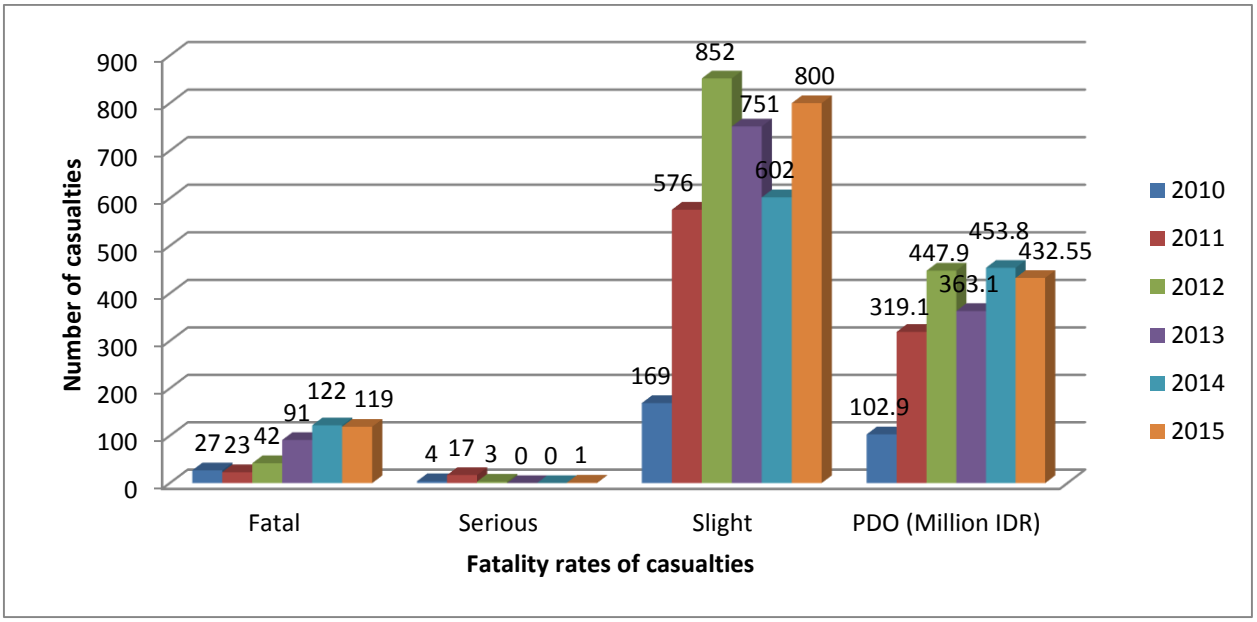


Figure 2 Fatality rate of traffic accident casualties from 2010 to 2015

3.2 Vehicles Involved in Traffic Accident

Characteristics of the accident based on the type of vehicles that involved in traffic accidents from 2010 to 2013 results 72.13% involved motorcycles (1915 vehicles), 5.99% involving passenger cars, jeep (159 vehicles), 2.03% involve bus (54 vehicles), 7.38% involved trucks (196 vehicles), and only 2.79% involved un-motorized vehicles (74 un-motorized: bicycle). There are 257 pedestrian (9.68%) that involved traffic accident in Purbalingga. Pedestrian, cyclists, and motorcyclists are vulnerable road users. Grouping types of vehicles involved in accidents by type of accident is presented in Table 1 below.

Based on Table 1, we know that the number of accident in Purbalingga, Central Java, Indonesia from 2010 (93 accidents) to 2013 (467 accidents) is increasing by more than 402%. In 2015, there are 548 accidents, it means increasing by more than 489% from 2010. This condition is very different with the condition in Dhaka, Bangladesh. The number of accidents in Dhaka is reducing by more than 10% percent every year and 63% of the accidents took place where there was no traffic control [23]. Beck *et al*. [24] used vehicle travel data to calculate fatal and non-fatal traffic injury rates per 100 million person-trips by travel mode, sex, and age group. Fatal and non-fatal injury rates were highest for motorcyclists, pedestrians, and bicyclists. Traffic injury rates for motorcyclist is 551.2 per 100 million person-trips for male and 434.1 per 100 million person-trips for female. Traffic injury rates for cyclist is 27.6 per 100 million person-trips for male and 7.2 per 100 million person-trips for female [24].

Table 1 Vehicle involved in traffic accident from 2010 to 2013 [19]

Year	Number of accident	Vehicle involved traffic accident					Pedes-trian	Total vehicle
		Motor cycle	Passenger car, Jeep	Bus	Truck	Un-motorist		
2010	93	103	15	18	19	6	15	176
2011	301	422	43	8	48	17	63	601
2012	475	712	40	14	75	31	88	960
2013	467	678	61	14	54	20	91	918
Total	1336	1915	159	54	196	74	257	2655

The New Zealand Ministry of Transportation (NZMT) calculates crash injury rates per unit of travel time, as indicated in the Figure 3 below. Measured this way, motorcycle travel has the highest risk, followed by cycling, automobile travel, walking and public transit [25]. The result in Purbalingga is in line with the findings of Beck *et al.* [24] and NZMT [25], that motorcyclists are the highest of vehicles that involved traffic accident.

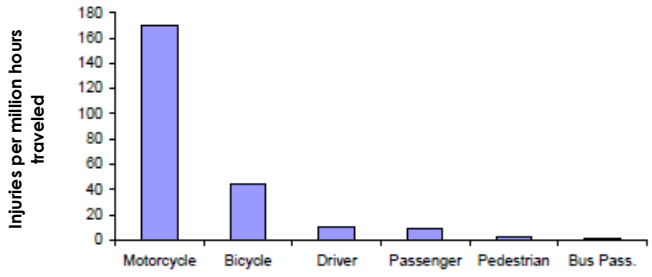


Figure 3 Time based injury risk by mode in New Zealand [25]

World Health Organization (WHO) state that each fatality is estimated to represent 15 severe injuries requiring hospital treatment, 70 minor injuries, and about 150 property damage only (PDO) traffic crashes, so the lifetime chance of a traffic crash injury typically ranges from 2.25% to 22.5% [26].

3.3 Accident Cost using Human Capital Method

a. Component of Accident Cost

Traffic accidents cost components includes direct costs and indirect costs. Indirect costs are a percentage of direct costs. Component of direct costs of traffic accidents includes property damage, administrative costs, medical costs, and loss of productivity [10].

b. Direct Cost

Direct costs include costs of property damage, medical costs or medical care, administrative costs, and loss of productivity (lost output). The amount of direct costs based on the level of fatality rate of casualties obtained based on

interviews with 25 casualties of property damage only (PDO), 30 casualties of slightly accidents, 20 casualties of serious accidents, and 25 families of casualties of fatal accidents. The total respondent is 100 peoples. The loss of productivity is the result of an accident victim's loss of income is calculated based on the income the victim and the victim productive age. In the analysis of the victim's income is expected to rise by 6% per year. For injuries, loss of productivity is calculated based on how long concerned cannot work because of a traffic accident. For the casualties is died, loss of productivity is calculated based on the amount of productive age expectations set in 60 (sixty) years old. For seriously injured and slightly injured lost productivity is calculated as the length of time they cannot work multiplied by the income the casualty if they works. The analysis results of the direct costs of casualties based on fatality rates are shown in Table 2.

c. Indirect Cost

Indirect costs are costs incurred by the family or relatives of the victims and the cost of pain, grief, and suffering (human cost). Human cost is a percentage of direct costs. According to Silcock and TRL [20], the amount of indirect costs is 28% for fatality, 50% for serious injury and 8% for slight injury. In Indonesia, percentage of human cost according to Pd.T-02-2005-B is 38% for fatality, 100% for serious injury, and 8% for slight injury [27]. Results of the analysis of indirect costs according to Silcock and TRL and based on Pd.T-02-2005-B are shown in Table 3.

Table 2 Direct costs based on the fatality rate of casualties (IDR)

Component of accident cost	Fatality rates of casualties			
	Fatality	Seriously injury	Slightly injury	PDO
Property damage	3,149,663	2,124,850	1,892,122	2,835,714
Administrative cost	1,226,400	437,500	223,667	212,200
Medical care	3,062,500	7,015,750	2,926,000	0
Lost output	384,132,000	3,005,200	750,533	0
Total cost unit	391,570,563	12,583,300	5,792,322	3,047,914

Table 3 Indirect costs or human cost (IDR)

Human cost	Fatality rates of casualties		
	Fatality	Seriously injury	Slightly injury
Silcock and TRL	109,639,758	6,291,650	463,386
Pd.T-02-2005-B	148,796,814	12,583,300	463,386

3.4 Casualty Cost by Severity Type

Casualty cost by severity type of accident is obtained by summing the cost of direct and indirect costs according to Silcock and TRL. Casualty accident costs by severity type: fatality is IDR501,210,320 (US$37,168), serious injury is IDR18,874,950 (US$1,400), slight injury is IDR6,255,708 (US$464), and property damage only is IDR3,047,914 (US$226). A result of the analysis of casualty cost by severity type is presented in Table 4.

The result of this study is similar with research of Sugiyanto [3] in Banyumas Regency, Central Java Province, Indonesia, casualty cost by severity type for seriously injury is IDR12,221,903.78. The value of casualty cost for fatality in Banyumas is smaller than in Purbalingga. The casualty cost for fatality in Banyumas Regency, Central Java, Indonesia is IDR89,873,969.68 and for slight injury is IDR877,574.13.

[3, 28]. Human cost value according to Silcock and TRL [20], the casualty cost by the severity type in Banyumas is IDR83,366,218.25 for fatality and IDR9,492,999.33 for seriously injury [28].

3.5 Accident Cost by Severity Type

a. Ratio of Vehicles Involved in Traffic Accident

To calculate the accident costs by severity type, it must first be calculated ratio of the vehicle involved in the traffic accident. Ratio of vehicles involved in traffic accident is classified by the accident type: fatal (1.773), serious (1.875), slight (1.814), and property damage only (1.333). The ratio of vehicles involved in traffic accident is presented in Table 5.

b. Average of Casualties per Cases and Severity

In addition to calculate the cost per accident or accident cost by severity type of the accident must be calculated the average casualties of a traffic accident. Accident casualties are separated according to the severity of the casualties then the number of casualties based on the severity of accidents divided by the number of accidents based on fatality rates. In Purbalingga during 2010-2013 there are 172 fatal accidents, 16 serious accidents, 1127 slight accidents, and 21 property damage only accidents. Number of casualties in fatal accident is 183 fatal, 7 seriously injured, 161 slightly injured, and material losses are IDR200,150,000. Number of casualties in serious accident is 18 seriously injured, 13 slightly injured, and material losses are IDR14,000,000. Number of casualties in slight accident is 2176 slightly injured and material losses is IDR887,650,000. Total of the property damage only is IDR79,400,000. Average of casualties' per-accident in Purbalingga during 2010-2013 is:

1) Fatal accident: 1.064 fatalities, 0.041 seriously injured, and 0.936 slightly injured.
2) Serious accident: 1.125 seriously injured and 0.812 slightly injured.
3) Slight accident: 1.931 slightly injured.

Number of casualties and average of casualties' per-accident in Purbalingga during 2010-2013 are shown in Table 6.

Table 4 Casualty cost by severity type (IDR) in Purbalingga

Cost component	Fatality rates of casualties			
	Fatality	Seriously injury	Slightly injury	PDO
Direct cost	391,570,563	12,583,300	5,792,322	3,047,914
Indirect cost	109,639,758	6,291,650	463,386	0
Total cost unit	501,210,320	18,874,950	6,255,708	3,047,914

Table 5 Ratio of vehicles involved in traffic accident (per accident) in Purbalingga 2010-2013

Accident type	Total accident	Total vehicles	Ratio of vehicles involved in traffic accident
Fatal	172	305	1.773
Serious	16	30	1.875
Slight	1,127	2,044	1.814
PDO	21	28	1.333
Total	1,336	2,407	

Table 6 Number and average of casualties' per-accident in Purbalingga 2010-2013

Accident type	Total accident	Number of casualties (people)			Material losses	Average casualties/accident			Material losses/accident
		Fatal	Serious	Slight	IDR	Fatal	Serious	Slight	IDR/case
Fatal	172	183	7	161	200,150,000	1.064	0.041	0.936	1,163,663
Serious	16	0	18	13	14,000,000	0	1.125	0.812	875,000
Slight	1,127	0	0	2,176	887,650,000	0	0	1.931	787,622
PDO	21	0	0	0	79,400,000	0	0	0	2,835,714
Total	1,336	183	25	2,350	1,201,200,000				

c. Direct Cost, Indirect Cost, and Accident Cost

Calculation of the accidents cost per cases is analyzed by calculating the direct costs and indirect costs. A result of calculation for the direct costs is shown in Table 7, while for the indirect costs per accident shown in Table 8. Direct cost and indirect cost per-accident in Purbalingga is:

1) Fatal accident: the direct cost is IDR422,923,333 and human cost (indirect cost) is IDR118,418,533.
2) Serious accident: the direct cost is IDR 18,918,763 and indirect cost is IDR9,459,381.
3) Slight accident: the direct cost is IDR10,962,141 and indirect cost is IDR876,971.
4) Property damage only: the direct cost is IDR3,993,152 and human cost is IDR 0.

Traffic accident cost by the severity type of accident is obtained by summing the direct cost and indirect costs according to Silcock and TRL [20]. Accident costs by the severity type: fatality is IDR541,341,866 (US$40,144), serious injury is IDR28,378,144 (US$2,104), slight injury is IDR11,839,112 (US$878), and property damage only is IDR3,993,152 (US$296). Result of the analysis of accident cost by severity type is presented in Table 9.

Table 7 Direct costs per accidents in Purbalingga (IDR)

Component of accident cost	Accident type			
	Fatal	Serious	Slight	PDO
Property damage	5,585,158	3,984,094	3,431.675	3,780.952
Administrative cost	1,532,000	673,917	431,853	212,200
Medical care	6,282,754	10,270,094	5,649,491	0
Lost output	409,523,420	3,990,658	1,449,122	0
Total cost unit	422,923,333	18,918,763	10,962,141	3,993,152

Table 8 Indirect costs per accident (IDR)

Human cost (indirect cost)	Fatality rates		
	Fatality	Serious injury	Slight injury
Silcock and TRL	118,418,533	9,459,381	876,971
Pd.T-02-2005-B	160,710,866	18,918,763	876,971

Table 9 Accidents cost per cases (IDR)

Component cost	Accident cost by severity type per accident			
	Fatal	Serious	Slight	PDO
Direct cost	422,923,333	18,918,763	10,962,141	3,993,152
Indirect cost	118,418,533	9,459,381	876,971	0
Total cost unit	541,341,866	28,378,144	11,839,112	3,993,152

3.6 Purbalingga Regency Accident Cost

The Purbalingga regency accident cost is obtained by multiplying the number of casualties and unit cost for each level of severity. Table 10 illustrates the total regency economic loss due to road accidents. Using the 2015 Purbalingga Regency nominal gross domestic product (GDP) of IDR18,565,114.2 million (US$1,376 million) [29], the total accident cost in Purbalingga was estimated to be roughly IDR236,517,103,652 (US$17,539,274) or 1.27% of the gross domestic product in 2015. Road accident cost in Purbalingga Regency has a percentage of GDP lower than in Indonesia. Accident cost in Indonesia was estimated to be roughly 2.9% of the gross domestic product.

Table 10 Accident cost in Purbalingga Regency

Severity	Number of casualties	Cost unit (IDR)	Total cost (IDR)
Fatal	424	501,210,320	212,513,175,838
Serious	25	18,874,950	471,873,750
Slight	3,750	6,255,708	23,458,904,122
PDO	25	3,047,914	73,149,943
Total	4,223		236,517,103,652
Gross domestic product	IDR 18,565,114.2 million [28]		
Percent of GDP	1.27%		

Many factors affect crash rates including roadway design, traffic speeds, traffic density, vehicle mix, and speed variation [30]. The World report on road traffic injury prevention, launched jointly in 2004 by the World Health Organization (WHO) and the World Bank, identified improvements in road safety management that have dramatically decreased road traffic deaths and injuries in industrialized countries that have been active in road safety. The report showed that the use of seat belts, helmets and child restraints has saved thousands of lives. The introduction and enforcement of appropriate speed limits, the creation of safer infrastructure, the enforcement of blood alcohol concentration limits and improvements in vehicle safety, are all interventions that have been tested and repeatedly shown to be effective [4]. One of the alternatives to reduce the accident cost is identification of black spot location [31].

Accident costs can be reduced by reducing accident frequency and reducing injury severity. Primary safety measures reduce accident frequency e.g. improved road geometry, relocation of poles, etc. Secondary safety measures reduce injury severity e.g. seat belts [4, 32], energy-absorption systems [32]. The aims of General Plan on Road

Safety or *Rencana Umum Nasional Keselamatan* (RUNK) *Jalan* 2011-2035 is to reduce the fatality rate of traffic accidents by 50% in 2020 based on 2010 data. RUNK use the indicator fatality rate per 100,000 population and Case Fatality Rate (CFR) as a tool to measure and evaluate the success of road safety performance. In 2020, the fatality desired index is 1.96 per 10,000 vehicles [33]. In 2010, the fatality rate is 13.151 per 100,000 population and the target in 2020 would be 6.57 (50% reduction) [33].

4.0 CONCLUSION

Based on the results, the following conclusion can be drawn:

a) Casualty accident costs by severity type: fatality is IDR501,210,320 (US$37,168), serious injury is IDR18,874,950 (US$1,400), slight injury is IDR6,255,708 (US$464), and property damage only is IDR3,047,914 (US$226).
b) Road traffic accidents cost in Purbalingga by severity type: fatality is IDR541,341,866 (US$40,144), serious injury is IDR28,378,144 (US$2,104), slight injury is IDR11,839,112 (US$878), and property damage only is IDR3,993,152 (US$296).
c) Total accident cost in Purbalingga was estimated IDR236,517,103,652 (US$17,539,274) or 1.27% of the gross domestic product in 2015.

Acknowledgement

This research was carried out by the financial support of Directorate General of Higher Education, Ministry of Education and Culture, Republic of Indonesia through Research Grant "*Hibah Penelitian Kerjasama antar Lembaga dan Perguruan Tinggi*" and Research Grant: Doctorate Development Program (Beasiswa Unggulan Program Pengembangan Doktor or P2D). All the contributions are acknowledged.

References

[1] Ministry of Transportation. 2015. *Perhubungan Darat dalam Angka 2014*. Direktorat Jenderal Perhubungan Darat. Jakarta: Ministry of Transportation Republic of Indonesia.
[2] Korps Lalu Lintas (Korlantas) Polri. 2014. *Polantas dalam Angka 2014*. Jakarta: Korlantas Kepolisian Negara Republik Indonesia.
[3] Sugiyanto, G. 2010. Kajian Karakteristik dan Estimasi Biaya Kecelakaan Lalu Lintas Jalan di Banyumas, Indonesia dan Vietnam. *Jurnal Berkala Transportasi FSTPT*. 10(2): 135-148.
[4] Global Road Safety Partnership (GRSP). 2008. *Speed Management (Road Safety Manual for Decision-Makers and Practitioners)*. Switzerland: Geneva.
[5] Sutomo, H. 2000. Road Accidents in Indonesia. *Journal of International Association of Traffic and Safety Sciences*. 23(2): 110-113.
[6] Asian Development Bank (ADB). 2005. *The Cost of Road Traffic Accidents in Indonesia*. ADB-Association of Southeast Asian Nations (ASEAN) Regional Road Safety Program, Accident Costing Report AC 03: Indonesia.
[7] Hills, P. J. and M. W. Jones-Lee. 1981. *The Costs of Traffic Accidents and Evaluation of Accident Prevention in Developing Countries*. PTRC Annual Meeting. PTRC Education and Research Services.
[8] Putignano, C. and L. Pennisi. 1999. Social Cost of Road Accident (Italian Case Study). *Journal of International Association of Traffic and Safety Sciences*. 23(2): 99-108.
[9] Anh, T. Thuy, T. T. Anh, and N. X. Dao. 2005. The Cost of Road Traffic Accident in Vietnam. *Proceedings of Eastern Asia Society for Transportation Studies (EASTS)*. 1923-1933.
[10] Transport Research Laboratory (TRL). 1995. *Costing Road Accident in Developing Countries, Overseas Road Note 10*. United Kingdom: Overseas Centre, Crowthorne, Beshire.
[11] Miller, T. 1991. *The Cost of Highway Crashes*. Federal Highway Administration (FHWA)-RD-91-055. United States Department of Transportation.
[12] Sugiyanto, G. 2016. The Impact of Congestion Pricing Scheme on the Generalized Cost and Speed of Motorcycle to the City of Yogyakarta, Indonesia. *Journal of Engineering and Applied Sciences*. 11(8): 1740-1746.
[13] Direktur Keselamatan Transportasi Darat (DKTD). 2006. Manajemen Keselamatan Transportasi Jalan, Workshop Manajemen Keselamatan Transportasi Darat. Batam: Direktorat Jenderal Perhubungan Darat. 13 Desember 2006.
[14] Al-Masaeid, H. R., A. A. Al-Mashakbeh, and A. M. Qudah. 1999. Economic Costs Of Traffic Accidents In Jordan. *Accident Analysis & Prevention*. 31(4): 347-357.
[15] Connely, L. B. and R. Supangan. 2006. The Economic Costs of Road Traffic Crashes: Australia, States and Territories. *Accident Analysis & Prevention*. In Press.
[16] Chin, H. C., M. M. Haque, and Y. H. Jean. 2006. An Estimate of Road Accident Costs In Singapore. *Proceedings of International Conference on Road Safety in Developing Countries*. Dhaka, Bangladesh. 28-35.
[17] Thongchim, P., P. Taneerananon, P. Luathep, and P. Prapongsena. 2007. Traffic Accident Costing for Thailand. *Journal of the Eastern Asia Society for Transportation Studies*. 7: 2891-2906.
[18] Pemerintah Daerah Kabupaten Purbalingga. 2015. *Map of Purbalingga Regency*. Purbalingga.
[19] Kepolisian Resor (Polres) Purbalingga. 2016. *Data Kecelakaan Lalu Lintas di Purbalingga Tahun 2010-2015*. Unpublished. Purbalingga: Kepolisian Resor Purbalingga.
[20] Silcock, R. and Transport Research Laboratory (TRL). 2003. *Guidelines for Estimating the Cost of Road Crashes in Developing Countries*. Department of International Development. Project R7780.
[21] Undang-Undang No. 14 Tahun 1992 tentang Lalu Lintas dan Angkutan Jalan. Jakarta: Ministry of Transportation Republic of Indonesia.
[22] Undang-Undang No. 22 Tahun 2009 tentang Lalu Lintas dan Angkutan Jalan. Jakarta: Ministry of Transportation Republic of Indonesia.
[23] Ahmeda, I., B. Ahmed, and M. R. Hainin. 2014. Road Traffic Accident Characteristics in Dhaka, Bangladesh. *Jurnal Teknologi*. 71(3): 75-82.
[24] Beck, L. F., A. M. Dellinger and M. E. O'Neil. 2010. Motor Vehicle Crash Injury Rates by Mode of Travel, United States: Using Exposure-Based Methods to Quantify Differences. *American Journal of Epidemiology*. 166(2): 212-218.
[25] New Zealand Ministry of Transport (NZMT). 2006. *Risks of Different Modes*. New Zealand: Ministry of Transport. Available at www.transport.govt.nz/risk-modes.
[26] World Health Organization (WHO). 2004. *World Report on Road Traffic Injury Prevention: Special Report for World Health Day on Road Safety*. World Health org. (www.who.int). Available at www.who.int/world-health-day/previous/2004/ en.

[27] Pusat Litbang Prasarana Transportasi. 2006. *Pedoman Perhitungan Besaran Biaya Kecelakaan: Pd.T-02-2005*. Jakarta: Departemen Permukiman dan Prasarana Wilayah, Ministry of Public Works.
[28] Sugiyanto, G. 2013. Perbandingan Biaya Kecelakaan Lalu Lintas dengan Metode *Gross Output* Kimpraswil dan *Transport Research Laboratory* (TRL). *Proceeding Symphosium International FSTPT XVI*. Surakarta: Universitas Muhammadiyah Surakarta. 175-185.
[29] Badan Pusat Statistik Kabupaten Purbalingga. 2016. *Purbalingga dalam Angka 2016*.
[30] Victoria Transport Policy Institute. 2016. *Transportation Cost and Benefit Analysis II – Safety and Health Costs*, www.vtpi.org/tca/tca0503.pdf.
[31] Sugiyanto, G., B. Mulyono, and M. Y. Santi. 2014. Karakteristik Kecelakaan Lalu Lintas dan Lokasi Black Spot di Kabupaten Cilacap, *Jurnal Teknik Sipil Universitas Atma Jaya Yogyakarta*. 12(4): 259-266.
[32] Nicholson, A. J. and M.R. Tight. 1989. *Accident Analysis and Prevention: Course Notes 1987/88*. Working Paper 272. Leeds: Institute of Transport Studies. University of Leeds, UK.
[33] Pemerintah Republik Indonesia. 2010. Rencana Umum Nasional Keselamatan (RUNK) Jalan 2011-2025. 1-40.