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Traffic Accident Cost Analysis Using The Gross Output (Human Capital) Method Approach

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A B S T R A C T

Based on the Tangerang Police traffic accident data, 1,559 accidents occurred in Tangerang Regency during the last 5 years and have increased every year. These problems need to be studied to determine the factors that cause accidents from the characteristics, and the amount of accident costs as an effort to improve traffic safety on the highway. The study used the EAN (Equivalent Accident Number) method to calculate accident rates and The Gross Output method to calculate accident costs. Based on the calculation of The Gross Output method, the total unit cost of accident victims is Rp. 2,084,725,349.34, - and the amount of accident victim costs is Rp. 9,817,644,067.75, -. The unit cost of an accident is Rp. 2,127,225,346.43, - and the amount of accident costs is Rp. 10,041,644,067.75.

1. Introduction

Tangerang Regency is a fairly densely populated area with various professions that require fast movement and access to heavy traffic and many cause high traffic volumes [1]. Transportation is a primary need for every community in carrying out mobility [2]. Based on the Tangerang Police traffic accident data, 1,559 accidents occurred in Tangerang Regency during the last 5 years and have increased every year. so it is very important to know the causes and characteristics of accidents and also the risk of accidents. Based on data available from the Tangerang Police in the last 5 years, accidents have often occurred on the Serang highway, especially at KM 26 - KM 35, with 116 accidents and 104 accident victims [3].

Based on the high number of accidents that occur, it is necessary to calculate the cost of accidents, because in Tangerang Regency there has been no calculation of accident costs. With such high costs, it is necessary to analyze the cost of accidents to improve road traffic

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safety. Investing in road safety improvement programs relies heavily on an economic assessment of road traffic crashes and their impacts. This evaluation underpins road safety interventions in a cost-benefit analysis [4]. There are several methods for determining crash costs, one of which is the willingness-to-pay (WTP) method. The willingness-to-pay method is widely used because it is more recommended by developed countries than the Gross Output method which is still used in developing countries, especially Indonesia [5].

A study in Myanmar using the Willingness-To-Pay method resulted in total mortality costs ranging from MMK 594.681 billion (US$ 495.567 million) to MMK 820.296 billion (US$ 683.580 million) in 2015. In addition, WTP was found to be significantly associated with age, family status, education, employment, individual income, household income [6], vehicle use, traffic exposure, drunk driving, personal experience, and traffic accident risk [7]. In a similar study, travel cost, accident rate on the chosen route, age [8], occupation, personal income, and number of household members were significant. The WTP value of road accidents for two-wheeler users was found to be Rs 0.4232/person/trip [9]. The cost of traffic accidents among motorcyclists shows that it is much higher than the global average [10]. The Willingness To Pay study showed that the cost of road traffic accidents in Egypt is about 52 billion Egyptian Pounds (about $US 6.6 billion). This study and research in other countries show that willingness to pay is an important prerequisite for investment in road safety [11].

As in many developing countries, economic losses due to traffic accidents in Indonesia are substantial; however, analytical research to estimate the magnitude and impact of these losses is lacking. As a developing country, the Gross Output method is still used in Indonesia. According to the results of research in several regions using the Gross Output (Human Capital) Method in Demak Regency, the cost of accidents from 2012 to 2016 amounted to Rp. 3,508,345,910, [12]. Road sections in Jember obtained the cost of accident victims for three years (2017-2019) amounted to Rp. 162,010,233,179 and the number of traffic accident costs (2017 - 2019) amounted to Rp. 192,779,704,983 [13]. Kupang City the cost of traffic accident victims is Rp.13,196,013,148, whereas the cost of accidents in 2013 amounted to Rp. 514,013,928 / km [14]. Garut Regency the cost of accident victims in 2015-2019 amounted to Rp.261,793,420,717, - and the cost of insurance compensation from PT Jasa Raharja is Rp.95,240,000,000 [15]. Pekanbaru City in the year (2014 - 2016) amounted to Rp. 6,323,769,000 [16]. The total cost of accident victims on the Sumenep-Pamekasan Highway section in 2020 amounted to IDR 16,431,044,096 [17]. The cost of accident victims based on 10 road sections in Tuban Regency in 2020 amounted to Rp 11,092,312,461 [18].

Apart from the national road section, similar research using The Gross Output (Human Capital) Method has been carried out on toll roads with the results of analyzing traffic accident costs on the Cipularang Purwakarta Toll Road Section totaling IDR 17,461,712,910.35 [19]. The amount of accident costs on the Jati Luhur Toll Road from 2012 to June 2021 is IDR 182,574,325,950 [20]. The total cost of accidents in Purbalingga is estimated at IDR 27,582,518,750 or 0.38% of gross domestic product [21]. Based on previous research, it was found that costs varied, therefore this study aims to analyze the cost of traffic accidents on the Serang Balaraja Road Section of Tangerang Regency KM 26 - KM 35 with different road lengths, characteristics, and years of research. The method used to calculate the accident rate is the EAN (Equivalent Accident Number) method which is the weighting of the equivalent number of accidents referring to the cost of traffic accidents and the amount of traffic accident costs using The Gross Output (Human Capital) method.

2. Research Method

Based on the objectives and issues raised, this research is included in quantitative research. This research aims to analyze the cost of traffic accidents. This research was conducted on the Jalan Serang Balaraja KM 26 - KM 35 section in Tangerang Regency. Data collection was conducted. Data collection from several agencies, namely the police, hospitals,

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insurance services, and BPS. After collecting secondary data, data processing was carried out which included an analysis of the EAN method, and an analysis of accident cost calculations using the gross output method.

3. Description and Technical

1. Research Location
   This research was conducted on the Jalan Serang Balaraja KM 26 - KM 35 section in Tangerang Regency.
2. Data Collection Technique
   The following is the data collection method that will be carried out in this study by submitting data requests to the relevant agencies, namely:
   a. Cost data of accident victims, the data is obtained from Balaraja Hospital, Tangerang Regency.
   b. Data on traffic accidents in 2018 - 2022 the data was obtained from the Tangerang Police Traffic Unit.
   c. Data on compensation for accident victims the data is obtained from Jasa Raharja
   d. Population data obtained from BPS Tangerang Regency.
3. Instrument Analysis Tool.
   Traffic accident data obtained from the police are analyzed using the EAN method, EAN is calculated by summing the number of accidents on each kilometer of road length and then multiplying by the weight value according to severity.
   To calculate the amount of traffic accident costs in this study, we used the guidelines for calculating the amount of updated traffic accident costs used by the transportation infrastructure R&D center. The approach used in this guideline is the Gross Output (Human Capital) Method.
4. Data Analysis Techniques.
   a. Accident Prone Location Analysis
      Techniques for ranking accident locations are based on the accident rate approach and quality control statistics, or weighting based on accident values. One method for calculating accident rates is the EAN (Equivalent Accident Number) method, which is a weighted equivalent accident number that refers to the cost of traffic accidents.
      EAN is calculated by summing the number of accidents on each kilometer of road length and then multiplying it by the weight value according to the severity. The standard weight values used are death victims or fatality (FAT), serious injuries or severe injury (SVI), slight or minor injuries (MNI), or property damaged only (PDO). EAN is calculated using the following formula Direktorat Jendral Perhubungan Darat [22]
      EAN=12 FAT+6 SVI+3 MNI+1PDO (1)
   b. Determination of the unit value of victim costs (BSKK)
      The determination of the unit value of casualty costs (BSKK) is obtained by calculating several parameters. Each parameter is categorized based on the fatality rate of the victim (death, serious injury, and minor injury).
      $BSKK = B_K + B_P + B_{AJ}$ (2)
      With BK: The amount of the victim's medical expenses; BP: The amount of the victim's lost productivity; BAJ: The cost of life insurance for accident victims.
      The cost of lost productivity (BP) parameter is divided based on the fatality level of the victim (death, serious injury, and minor injury). The BP died parameter is obtained by calculating using:
      $BP = JP\ (U_{HP} - U_{RK})$ (3)
      With JP: Total fixed income of the victim (Rp/year); U_{HP}: Life expectancy; U_{RK}: Average age of accident victims.
      The BP parameters of severe and minor injuries were obtained using the equation

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$$BP = \frac{Jp}{(12 \times J_{HK})} \quad (4)$$

With JP: Total fixed income of the victim (Rp/year); JHK: Number of working days in one month.

c. Determination of the unit value of accident costs (BSK)
Determination of the unit value of accident costs (BSK) is obtained from the calculation results using the formula

$$BSK = BSKK + B_K + B_A \quad (5)$$

With BSKK : The amount of the unit value of the cost of accident victims; BK: The amount of vehicle repair costs; BA: Administrative costs of case settlement.

d. Cost of Traffic Accident Victims (BBKO)
The formula for calculating the cost of traffic accident victims is as follows:

$$BBKO\ (T_n) = \sum_{j=i}^{m} (JKO_j\ X\ BSKK_j(T_n)) \quad (6)$$

With BBKO: The cost of traffic accident victims (Rp/year); JKOj: The number of categories of traffic accident victims (victims/year); BSKKj(Tn): Unit cost for the category of traffic accident victims in year n (Rp/victim).

e. Amount of Traffic Accident Fee (BBKE)
The formula for calculating the cost of traffic accidents is as follows:

$$BBKE\ (T_n) = \sum_{i=1}^{k} (JKE_i\ X\ BSK_i(T_n)) \quad (7)$$

With BBKE: The cost of traffic accidents in year n (Rp/year); JKEi: The number of traffic accident classes (accidents/year); BSKi (Tn): Unit cost for traffic accident class in year n (Rp/accident).

4. Results and Discussions

4.1 Number of Traffic Accidents

The number of accidents that occurred for 5 years from 2018 - 2022 on Jl. Raya Serang Km 26 - Km 35 there were 116 incidents, where the accident had victims involved, but not all incidents had victims. The following 5-year accident data can be seen in Table 1.

Table 1. Number of Accidents in 5 Years

Years	2018	2019	2020	2021	2022
Incidents	19	23	28	19	27

Source: Research Data, 2023

4.2 Number of Traffic Accident Victims

The number of accident victims who occurred during the 5 years from 2018 - 2022 from 116 accidents there were 104 accident victims involved from minor injuries, serious injuries to death. The following is the data on the number of accident victims involved in Table 2.

Table 2. Number of traffic casualty class types

Years	FAT	SVI	MNI	Total/Years
2018	4	6	7	17
2019	3	11	7	21
2020	4	8	16	28
2021	2	3	13	18
2022	5	4	11	20
Total	18	32	54	104

Source: Research Data, 2023

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Based on the results of the analysis of accident characteristics on Jalan Raya Serang km 26 - km 35, namely the time of the accident at night a total of 44 incidents or 38%, based on the class of accident victims, namely minor injuries a total of 54 victims or 52%, based on the occupation of self-employed accident victims a total of 38 or 34%, based on the type/type of collision Front - rear a total of 34 incidents or 29%, based on the type of vehicle involved, namely motorcycle X motorcycle a total of 37 incidents or 32%, based on the age of the victim, namely at the age of 16 - 30 years a total of 54 victims or 48%, and for gender, namely male a total of 81 victims or 72%.

4.3 Determination of the Victim Cost Unit Value (BSKK)

To calculate the unit cost of accident victims using the equation in formula 2. The amount of Victim Treatment Costs (Bk) is the cost incurred by the victim or the victim's family, or charged to the insurance company. Where this data is secondary data obtained from the average cost of treating accident victims in Tangerang district, which is precisely on the Serang highway km 26 - km 35. The following is the calculation for the cost of treating accident victims in Table 3.

Table 3. Medical Expenses for Accident Victims

Years	FAT	SVI	MNI
2018	Rp 4.712.800,00	Rp 34.323.723,00	Rp 14.957.985,00
2019	Rp 4.915.433,00	Rp 35.335.938,00	Rp 15.358.520,00
2020	Rp 4.609.838,00	Rp 28.242.823,00	Rp 9.865.407,00
2021	Rp 4.460.279,00	Rp 16.276.711,00	Rp 8.340.683,00
2022	Rp 5.058.183,00	Rp 30.727.265,00	Rp 12.308.498,00

Source: Research Data, 2023

The cost of lost productivity is categorized based on the level of fatality of the victim, namely Death, Serious Injury, and Minor Injury. Police data related to the age of the victim becomes the material for determining the residual value of the age of accident victims in the World Death category, while the Severe Injury and Minor Injury categories are made into one group of values, where the determination of the value is obtained from the results of the analysis on the parameters of the Gross Regional Domestic Product (GRDP) per capita value, the number of months in a year, and the number of working days per month (assuming 20 days). And for the determination of the residual value of the average age of the victim is generated from the difference between the life expectancy minus the average age of the victim, where the life expectancy limit is assumed to be 60 years. The cost of lost productivity (BP) parameter is divided based on the fatality rate of the death victims or fatality (FAT), serious injuries or severe injury (SVI), and slight or minor injuries (MNI). The BP parameter of fatalities was obtained by calculating using the equation of formula 3.

The number of victims based on age shows that most victims occur at the age of 16 - 30 years and the average age is 30. The following is the calculation of the Cost of Lost Productivity (Death) in Table 4.

Table 4. Cost of Lost Productivity (FAT)

Study Area	PDRB Per Capita (Rp/Years)	Average Age (Years)	Lost Productivity (Rp)
Kab Tangerang 2018	Rp 7.636.822,00	30	Rp 229.104.660,00
Kab Tangerang 2019	Rp 8.240.546,00	30	Rp 247.216.380,00
Kab Tangerang 2020	Rp 7.984.216,00	30	Rp 239.526.480,00
Kab Tangerang 2021	Rp 8.546.098,00	30	Rp 256.382.940,00
Kab Tangerang 2022	Rp 9.421.657,00	30	Rp 282.649.710,00

Source: Research Data, 2023

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BP parameters for severe injuries and minor injuries were obtained using the equation of formula 4. Based on calculations using formula 4, the cost of lost productivity for victims of severe injuries and minor injuries is shown in Table 5.

Table 5. Cost of Productivity Loss (SVI/MNI)

Study Area	GRDP per Capita (Rp/Years)	Number of Months Per Year	Number of Days Per Month	Lost Productivity (Rp)
Kab Tangerang 2018	Rp 7.636.822,00	12	20	Rp 31.820,09
Kab Tangerang 2019	Rp 8.240.546,00	12	20	Rp 34.335,61
Kab Tangerang 2020	Rp 7.984.216,00	12	20	Rp 33.267,57
Kab Tangerang 2021	Rp 8.546.098,00	12	20	Rp 35.608,74
Kab Tangerang 2022	Rp 9.421.657,00	12	20	Rp 39.256,90

Source: Research Data, 2023

From the previous calculations of Accident Victim Care Costs, Lost Productivity Costs (FAT), and Lost Productivity Costs (SVI/MNI), the unit costs of accident victims for 5 years are obtained as follows in Table 6.

Table 6: Unit Cost of Accident Victims

Years	Victim Fatality	Unit Cost of Accident Victims
2018	FAT	Rp 283.817.460,00
	SVI	Rp 84.358.058,61
	MNI	Rp 34.989.805,09
2019	FAT	Rp 302.131.813,00
	SVI	Rp 85.370.273,61
	MNI	Rp 35.392.855,61
2020	FAT	Rp 294.136.318,00
	SVI	Rp 78.276.090,57
	MNI	Rp 29.898.674,57
2021	FAT	Rp 310.843.219,00
	SVI	Rp 66.312.319,74
	MNI	Rp 28.376.291,74
2022	FAT	Rp 337.707.893,00
	SVI	Rp 80.766.521,90
	MNI	Rp 32.347.754,90

Source: Research Data, 2023

The results of the Accident Victim Cost Unit from 2018 - 2022 experience differences in numbers, where in the FAT category the highest in 2022 is Rp. 337,707,893.00, the SVI categories are the highest in 2019 which is Rp. 85,370,273.61 and for MNI it is Rp. 35,392,855.00.

4.4 Determination of the unit value of accident cost (BSK)

Determination of the unit value of accident costs (BSK) is obtained from the results of calculations using the formula equation 5. The accident cost unit parameter consists of the cost of accident victims, vehicle costs, and administrative costs. The administrative cost parameter for each accident management is the cost contained in the cost of vehicle repairs, insurance claims, and crime scene inspection by the police. Therefore, administrative costs do not appear separately. Table 7 is a calculation to determine the unit cost of an accident.

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Table 7. Unit Cost of Accident

Years	Categories	Unit Cost of Accident Victims	Vehicle Repair Cost	Administration Fee	Accident Cost Unit
2018	FAT	Rp 283.817.460,00	Rp 5.000.000,00	-	Rp 288.817.460,00
	SVI	Rp 84.358.058,61	Rp 2.500.000,00	-	Rp 86.858.058,61
	MNI	Rp 34.989.805,00	Rp 1.000.000,00	-	Rp 35.989.805,00
2019	FAT	Rp 302.131.813,00	Rp 5.000.000,00	-	Rp 307.131.813,00
	SVI	Rp 85.370.273,61	Rp 2.500.000,00	-	Rp 87.870.273,61
	MNI	Rp 35.392.855,00	Rp 1.000.000,00	-	Rp 36.392.855,00
2020	FAT	Rp 294.136.318,00	Rp 5.000.000,00	-	Rp 299.136.318,00
	SVI	Rp 78.276.090,57	Rp 2.500.000,00	-	Rp 80.776.090,57
	MNI	Rp 29.898.674,00	Rp 1.000.000,00	-	Rp 30.898.674,00
2021	FAT	Rp 310.843.219,00	Rp 5.000.000,00	-	Rp 315.843.219,00
	SVI	Rp 66.312.319,74	Rp 2.500.000,00	-	Rp 68.812.319,74
	MNI	Rp 28.376.291,00	Rp 1.000.000,00	-	Rp 29.376.291,00
2022	FAT	Rp 337.707.893,00	Rp 5.000.000,00	-	Rp 342.707.893,00
	SVI	Rp 80.766.521,90	Rp 2.500.000,00	-	Rp 83.266.521,90
	MNI	Rp 32.347.754,00	Rp 1.000.000,00	-	Rp 33.347.754,00

Source: Research Data, 2023

The results of the Accident Cost Unit from 2018 - 2022 experience differences in numbers, where in the FAT category the highest in 2022 is Rp. 342,707,893.00, the SVI categories are the highest in 2019 which is Rp. 87,870,273.61 and for MNI it is Rp. 36,392,855.00.

4.5 Cost of Traffic Accident Victims (BBKO)

The calculation of the cost of victims of traffic accidents is calculated based on equation 6. The amount of the cost of victims of traffic accidents (BBKO) can be seen in Table 8.

Table 8. Costs for Accident Victims

Years	Categories	Unit Cost of Accident Victims	Number of Victims	Costs for Victims of Traffic Accidents
2018	FAT	Rp 283.817.460,00	4	Rp 1.135.269.840,00
	SVI	Rp 84.358.058,61	6	Rp 506.148.351,66
	MNI	Rp 34.989.805,00	7	Rp 244.928.635,00
2019	FAT	Rp 302.131.813,00	3	Rp 906.395.439,00
	SVI	Rp 85.370.273,61	11	Rp 939.073.009,71
	MNI	Rp 35.392.855,00	7	Rp 247.749.985,00
2020	FAT	Rp 294.136.318,00	4	Rp 1.176.545.272,00
	SVI	Rp 78.276.090,57	8	Rp 626.208.724,56
	MNI	Rp 29.898.674,00	16	Rp 478.378.784,00
2021	FAT	Rp 310.843.219,00	2	Rp 621.686.438,00
	SVI	Rp 66.312.319,74	3	Rp 198.936.959,22
	MNI	Rp 28.376.291,00	13	Rp 368.891.783,00
2022	FAT	Rp 337.707.893,00	5	Rp 1.688.539.465,00
	SVI	Rp 80.766.521,90	4	Rp 323.066.087,60
	MNI	Rp 32.347.754,00	11	Rp 355.825.294,00

Based on calculations using the Gross Output (Human Capital) method, the cost of traffic accident victims in Tangerang Regency in 2018 amounted to Rp. 1,886,346,826.66, - in 2019 it amounted to Rp. 2,093,218,433.71, - in 2020 it amounted to Rp. 2,281,132,780.56 while in

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2021 it amounted to Rp. 1,189,515,180.22, - and in 2022 it amounted to Rp. 2,367,430,846.60, -.

4.5 Amount of Traffic Accident Cost (BBKE)

The calculation of the amount of traffic accident costs uses the formula equation 7. The amount of Traffic Accident Costs (BBKE) can be seen in table 9.

Tabel 9. The amount of traffic accident cost (BBKE)

Years	Categories	Number of Victims	Accident Cost Unit	Total
2018	FAT	4	Rp 288.817.460,00	Rp 1.155.269.840,00
	SVI	6	Rp 86.858.058,61	Rp 521.148.351,66
	MNI	7	Rp 35.989.805,00	Rp 251.928.635,00
2019	FAT	3	Rp 307.131.813,00	Rp 921.395.439,00
	SVI	11	Rp 87.870.273,61	Rp 966.573.009,71
	MNI	7	Rp 36.392.855,00	Rp 254.749.985,00
2020	FAT	4	Rp 299.136.318,00	Rp 1.196.545.272,00
	SVI	8	Rp 80.776.090,57	Rp 646.208.724,56
	MNI	16	Rp 30.898.674,00	Rp 494.378.784,00
2021	FAT	2	Rp 315.843.219,00	Rp 631.686.438,00
	SVI	3	Rp 68.812.319,74	Rp 206.436.959,22
	MNI	13	Rp 29.376.291,00	Rp 381.891.783,00
2022	FAT	5	Rp 342.707.893,00	Rp 1.713.539.465,00
	SVI	4	Rp 83.266.521,90	Rp 333.066.087,60
	MNI	11	Rp 33.347.754,00	Rp 366.825.294,00

Based on calculations using the Gross Output (Human Capital) method, the amount of traffic accident costs in Tangerang Regency, which is precisely on Jalan Raya Serang km 26 - km 35 in 2018 amounted to Rp. 1,928,346,826.66, - in 2019 it amounted to Rp. 2,142,718,433.71, - in 2020 it amounted to Rp. 2,337,132,780.56, - while in 2021 it amounted to Rp. 1,220,015,180.22, - and in 2022 it amounted to Rp. 2,413,430,846.60.

5. Conclusion and Suggestion

5.1 Conclusion

The characteristics of accidents on the Serang road km 26 - km 35 are the time of occurrence of accidents at night as many as 44 incidents, namely the time of the accident at night a total of 44 incidents, based on the class of accident victims, namely minor injuries a total of 54 victims, based on the occupation of self-employed accident victims a total of 38, based on the type/type of front-rear collision a total of 34 incidents, based on the type of vehicle involved, namely motorcycles and motorcycles a total of 37 incidents, based on the age of the victims, namely at the age of 16 - 30 years a total of 54 victims, and for gender, namely male a total of 81 victims. Based on the calculation of The Gross Output method, the total unit cost of accident victims is Rp. 2,084,725,349.34, - and the amount of accident victim costs is Rp. 9,817,644,067.75, -. The unit cost of an accident is Rp. 2,127,225,346.43, - and the amount of accident costs is Rp. 10,041,644,067.75.

5.2 Suggestion

From the results of the study, it is expected that the government can use this study as a basis for determining the cost of traffic accidents and as a basis for determining the compensation budget. It is necessary to interconnect interrelated data between the police and accident agencies based on direct and indirect costs. In addition, it is expected that there will be further studies conducted.

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