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Analysis of Traffic Accidents and Handling with Aek and Bka Methods to Determine Accident-Prone Areas (A Case Study of The Bogor District Government Road Area)

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Abstract

Bogor Regency with the largest population in Indonesia, namely as many as 5.9 million people. With the population in the area classified as very large, the number of traffic accidents in Bogor Regency is high, namely 357 accidents in 2018. It affects the level of traffic density, but this condition is not balanced with adequate road facilities and infrastructure and public transportation. Of course this causes an increase in the volume of traffic in the Bogor Regency Regional Government Road Area and also increases the potential for accidents. The research objectives were to determine the performance of roads, accident-prone roads, dominant causes of accidents, and to know the prevention of accidents in the Bogor District Government Road Area using the Accident Equivalent Rate (AEK), Upper Control Limit (BKA) method. Based on the analysis, it is concluded that Jalan Raya Bogor, Jalan Raya Sukahati - Karadenan, and Jalan Tegar Beriman are included in the category of roads prone to traffic accidents, because they have AEK values that exceed or are greater than the BKA and UCL values. The most common type of accident was Front-Forward crash, which accounted for 39.51% of the total number of accidents. The time of accidents that most often occur in the area of Bogor Regency Regional Government Road is in the morning at 00.00 WIB - 06.00 WIB with a percentage of 28.53% of the number of accidents.

Keywords
Accident Equivalent Rate, Accident-Prone Areas, Roads, Traffic Accidents,

1. Introduction

1.1 Background

In Indonesia, the number of accidents that occurred during 2013 to 2018 is quite high. The highest number of accidents occurred in 2016, where there were accidents as many as 106,644 cases. West Java Province is one of the provinces with the largest population in Indonesia with a population of 49.02 million. One of the several districts in West Java is Bogor Regency with the largest population in Indonesia, namely as many as 5.9 million people. With the population in the area classified as very large, the number of traffic accidents in Bogor Regency is high, namely 357 accidents in 2018. This condition is not matched by adequate road facilities and infrastructure and public transportation.

Based on the above background, in this case it is necessary to carry out a traffic accident analysis which includes identification of accident-prone locations, identification of accident characteristics, and proposed handling of accident-prone areas. So in an effort to add to the scientific repertoire to help reduce accidents in the Bogor Regency Regional Government Road Area, it is necessary to conduct a study with the title "Traffic Accident Analysis and Handling with AEK and BKA Methods to Determine Accident-Prone Areas." (A Case Study of Bogor District Government Road Area).

2. Literature Review

2.1 Road Section Performance

Road performance is the ability of a road to serve the needs of traffic flow according to its function which can be measured and compared with road service level standards. The value of road service level is used as a parameter of road performance (Valent et al., 2002).

Meanwhile, according to MKJI (1997), road performance can be measured based on several parameters, including:

Degree of saturation (DS), namely the ratio of traffic flow (pcu / hour) to capacity (pcu / hour) on a certain road section.

2.2 Roads and Traffic Accidents

Roads are land transportation infrastructure covering all parts of the road, including complementary buildings and equipment intended for traffic, which are on the ground surface, above the ground surface, below the ground and / or water, and above the water surface, except for railways, roads. lorries, and cable roads (Nugroho, Sutarto, Endradewi, & Alisa, 2017) .

A traffic accident is an incident on the road which is unexpected and unintentionally involving a vehicle with or without other road users resulting in human casualties and / or property loss (WHO, 2018).

2.3 Identification of Accident Prone Locations

There is a method that can be used to identify accident-prone locations, namely the Accident Equivalent Rate (AEK) method. According to guideline Halim, Sultan, & Saing, (2018) regarding Handling of Traffic Accident-Prone Locations, AEK is the number used to weight the class of accidents, this figure is based on the value of accidents with material damage or loss.

To weight the rates of accidents that occur on roads, it is done by using a comparison of the monetary value of the cost of accidents, with a comparison:

M: B: R: K = M / K: B / K: R / K: 1……. (2.4)

with:

M = Passed Away
B = Serious Injury
R = Minor Injuries
K = Accidents with Material / Object Loss

3. Research Methodology

3.1 Research Location and Time

Analysis The research was conducted in the area of Jalan Pemda Bogor Regency. The time of writing of this research was carried out in February 2020 - July 2020 using data on traffic accidents in 2016 - March 2020. The road segment performance survey was conducted on Friday and Saturday at 06.30-07.30 WIB and 17.00-18.00 WIB.

3.2. Method of Analysis of Accident Handling Efforts

The purpose of this analysis is to provide an effort to deal with accidents at the accident location in the Bogor Regency Regional Government Road Area based on the accident situation at that location. This analysis can be done after looking at the types of accidents that are considered dominant in accident-prone locations. After obtaining the dominant type of accident at the accident location, a survey of road conditions and / or road safety facilities at the accident-prone location is carried out to obtain a recommendation for appropriate treatment.

4. Analysis and Discussion

4.1 Overview

The road sections around the Bogor Regency Regional Government sector consist of several roads, and in this research the road sections to be analyzed are 8 roads consisting of 1 national road section (Jl. Raya Bogor) and 7 regency roads (Jl. Raya Sukahati, Karadenan, Jl. Tegar Beriman, Jl. Sukahati-Bojong Gede, Jl. Cilebut-Citayam, Jl. Kemang-Kedungwaringin, Jl. Sentul-Kandang Roda, and Jl. Pomad Karadenan). The following is a map of the location of 8 roads (national road red color, district road blue color) which will be analyzed can be seen in Figure 1.

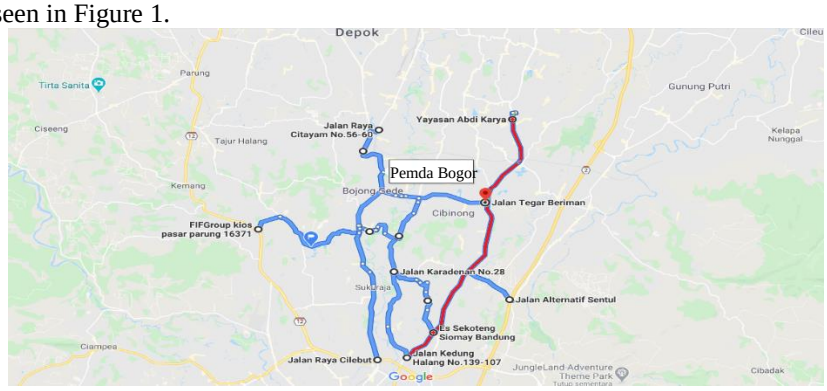

Figure 1. Location Map
Source: www.google.co.id/maps

4.2 Data Recapitulation

This data is obtained from POLRES DISTRICT BOGOR which is used to answer problems regarding the location of accident-prone points. The data obtained were in the form of data recapitulation of victim fatality, data on factors causing traffic accidents, and data on accident events. The recapitulation table of victim fatality data in the Bogor Regency Regional Government sector in 2016 to March 2020 each year can be seen in Table 1.

Table 1. Recapitulation of Total Victim Fatality Data

NO	Roads	Number Of Events	Victim			Number Of Victims	Material Losses	
			MD	LB	LR		THING	Rp
1	Jl. Raya Jakarta-Bogor	80	29	15	50	94	107	25,500,000
2	Jl. Raya Sukahati Karadenan	76	20	7	62	89	87	8,000,000
3	Jl. False	40	7	14	26	47	46	7,200,000
4	Jl. Sukahati-Bojong Gede	15	2	4	12	18	26	2,500,000
5	Jl. Cilebut-Citayam	4	0	0	5	5	11	800,000
6	Jl. Kemang-Kedungwaringin	18	7	4	10	21	29	2,200,000
7	Jl. Wheel Houses	9	0	3	8	11	17	2,050,000
8	Jl. Pomad Karadenan	0	0	0	0	0	0	-

Source: Bogor District Police

From the accident data on the road, the most frequent accidents are Jalan Raya Bogor with 80 incidents, followed by Jalan Raya Sukahati Karadenan with 76.

4.3 Road Section Performance Analysis

Based on the Recapitulation of Victim Fatality Data (Table 1.) the road with frequent accidents is Jalan Raya Bogor with a total of 80 incidents, therefore, first of all it is necessary to review how the performance on these roads is, the first step is to carry out a survey by counting the vehicles for 1 hour. at every busy hour, where the observation time taken is at 06.30 - 07.30 WIB, and 17.00 - 18.00 WIB, Based on the data obtained, the calculation of traffic volume, capacity, free flow speed, degree of saturation, travel time and analysis is carried out. service level based on the Indonesian Road Capacity Manual (MKJI),

4.3.1 Traffic Volume

Traffic volume is the number of vehicles passing on a certain road in hours.

Table 2. Traffic Volume During the Covid-19 Pandemic

No.	Road Width (m)	Roads	Time / Hour	Volume (pcu / hour) Weekdays	Volume (pcu / hour) of holidays
1	7	Bogor Direction	06.30 - 07.30	1409	1658
2	7		17.00 - 18.00	2035	2443
3	7	Direction of Jakarta	06.30 - 07.30	1514	1316
4	7		17.00 - 18.00	1781	1958

Source: Calculation Results

4.3.2 Free Flow Speed

Jalan Raya Bogor is a 4-lane - 2-way divided (4/2) road type, with a traffic lane width of 7 meters. The calculation of free flow speed is based on the Indonesian Road Capacity Manual (MKJI, 1997) for urban routes. The following is the calculation of the speed of the free flow of vehicles based on the MKJI 1997.

Table 3. Free Flow Speed During the Covid-19 Pandemic

Directions	Basic Free Flow Speed	Adjustment Factor For Path Width	FVo + FVw	Adjustment Factor		Free Flow Speed
				Side Barriers	City Size	
	FVo	FVw	(2) + (3)	FFVsf	FFVcs	FV (4) x (5) x (6)
	(km / hour)	(km / hour)	(km / hour)			(km / hour)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	57	0	57	1	1.03	58.71

Source: Calculation Results

4.3.3 Capacity

The capacity of Jalan Raya Bogor is calculated using the MKJI 1997 guidelines, the capacity is as follows:

Table 4. Capacity During the Covid-19 Pandemic

Directions	Basic Capacity	Adjustment Factor for Capacity				Capacity
		Lane Width	Direction Separator	Side Barriers	City Size	
	Co junior high school / hour	FCw	FCsp	FCsf	FCcs	C junior high school / hour (12) x (13) x (14) x (15) x (16)
(11)	(12)	(13)	(14)	(15)	(16)	(17)
1 (direction Bogor)	3300	1	1	0.96	1.04	3295
2 (direction to Jakarta)	3300	1	1	0.96	1.04	3295

Source: Calculation Results

4.3.4 Degree of Saturation and Service Level

The degree of saturation is the ratio between traffic volume and road capacity. The level of service is done by comparing the volume of vehicles in units of pcu / hour with the capacity of the roads. The following are the results of Degree of Saturation and Service Level for two directions:

Table 5. Degree of Saturation and Service Level During the Covid-19 Pandemic

Day	Time	Directions	Degree of Saturation	Service Level
Weekdays	Morning	Bogor	0.428	B
		Jakarta	0.459	B
	Afternoon	Bogor	0.618	C
		Jakarta	0.541	C
Weekend	Morning	Bogor	0.503	B
		Jakarta	0.399	B
	Afternoon	Bogor	0.741	C
		Jakarta	0.594	C

Source: Calculation Results

4.3.5 Comparison of The Degree of Saturation Before and During the Covid-19 Pandemic

Comparative data for the performance of Jalan Raya Bogor before Covid-19 used here is the journal by Rulhendri Agus Hasan from the University of Ibn Khaldun Bogor with the title 'Performance Evaluation of Jalan Raya Bogor (Case Study: Jalan Raya Bogor) ”in 2018.

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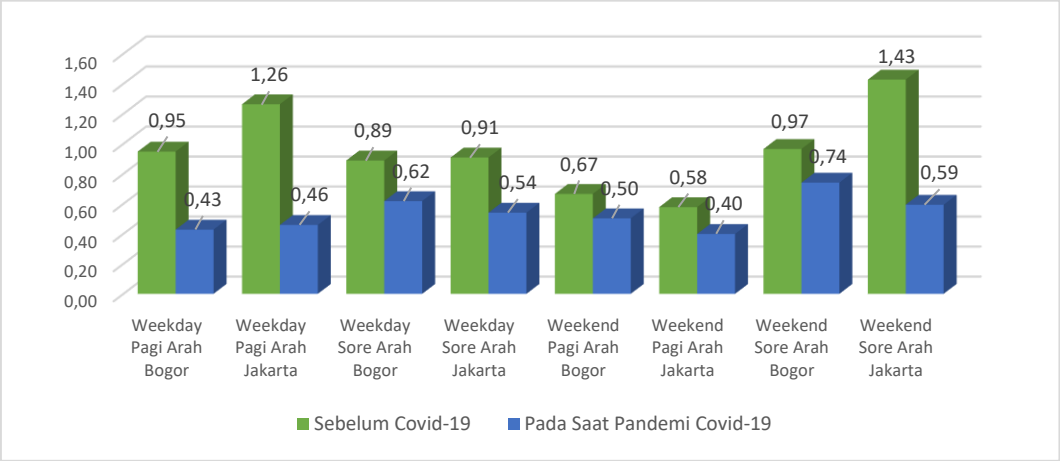

Figure 2. Comparison of the Degree of Saturation Before and During the Covid-19 Pandemic
Source: Calculation Results

4.4 Analysis of Accident Prone Areas

The analysis of accident-prone areas in this study uses the Accident Equivalent Rate (AEK) method. This method is used to determine accident-prone areas by ranking the AEK value with the Upper Control Limit (BKA) and Upper Control Limit (UCL) values based on the number and fatality rate of accident victims that occurred in the Bogor Regency Regional Government Road Area.

AEK formula:

AEK = 12MD + 3LB + 3LR + 1K (4.1)

The calculation of AEK that is reviewed is in the Bogor Regency Regional Government Road Area which is divided into 8 roads. The BKA calculation can be calculated using the average AEK value on the road sections under review.

BKA formula

BKA = C + 3√C (4.2)

Where the value of C is the average of the equivalent accident rate (AEK).

UCL calculations can be calculated using the average AEK value on the road sections under review.

UCL formula

$$UCL = \lambda + \Psi \times \sqrt{\left(\frac{\lambda}{m} + \frac{0{,}829}{m} + \left(\frac{1}{2}xm\right)\right)} \quad (4.3)$$

The results of the calculation of the identification of accident-prone locations using the AEK method can be seen in Table 6.

Table 6. Calculation of Accident-Prone Location Identification

NO	Roads	Score					
		AEK	C	BKA	λ	ψ	UCL
1	Jl. Raya Jakarta-Bogor	650	220,375	264,9101	220,375	2,576	266,839
2	Jl. Raya Sukahati Karadenan	534					262,500
3	Jl. False	250					249,277
4	Jl. Sukahati-Bojong Gede	98					238,818
5	Jl. Cilebut-Citayam	26					232,322
6	Jl. Kemang-Kedungwaringin	155					243,260
7	Jl. Wheel Houses	50					234,348
8	Jl. Pomad Karadenan	0					0,000

Source: Calculation Results

4.5 Analysis of Data Analysis Approaches

4.5.1 Causes of Accidents

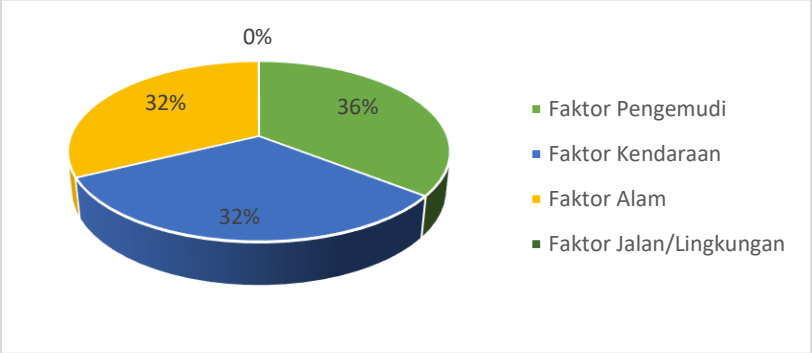

Figure 3. Pie Chart of Accident Causes
Source: Calculation Results

Based on the diagram in Figure 4, it can be seen that the largest percentage of the factors causing the accident is the driver factor.

4.5.2 Accident Type

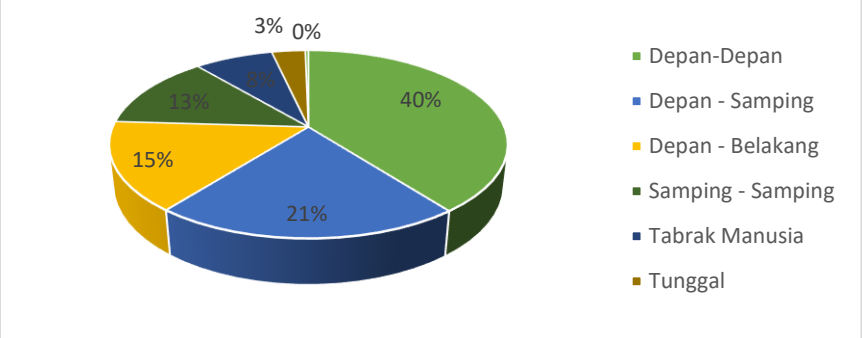

Figure 4. Pie Chart of Accident Types
Source: Calculation Results

Based on the percentage results in Figure 5, it can be seen that the largest percentage of accident types is front-to-front.

4.5.3 Time of The Crash

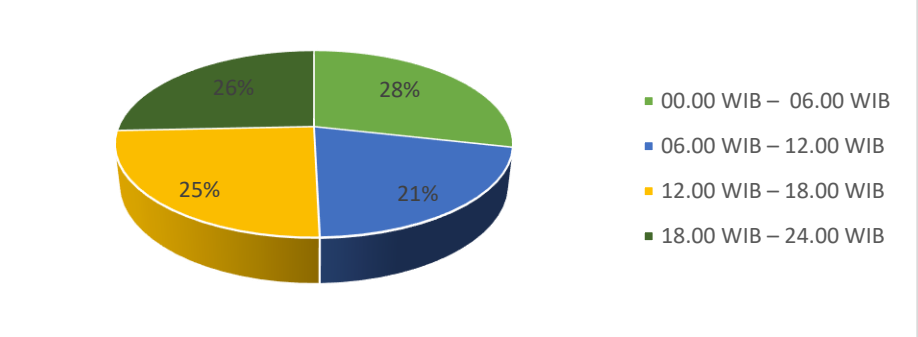

Figure 5. Time Accident Pie Chart
Source: Calculation Results

Based on the percentage results in Figure 5, it can be seen that the time of the biggest accident is 00.00 WIB - 06.00 WIB.

5. Conclusion

5.1 Conclusion

1. Based on the results of the analysis of the performance of Jalan Raya Bogor during the Covid-19 outbreak, the traffic volume on Jalan Raya Bogor is 1409 pcu / hour on Morning Workdays towards Bogor; 1514 pcu / hour on Morning Workdays towards Jakarta; 2035 pcu / hour on Afternoon Workdays towards Bogor; 1781 pcu / hour on Afternoon Work days towards Jakarta; 1658 junior high school / hour on Morning Holidays towards Bogor; 1316 pcu / hour on Morning Holidays towards Jakarta; 2443 pcu / hour on Afternoon Holidays towards Bogor; 1958 junior high school / hour on Afternoon Holidays towards Jakarta; while the capacity is 3300 pcu / hour. The free flow speed of the vehicle is 58.71 km / hour. The degree of saturation on Jalan Raya Bogor is 0.43 on a Morning Workday towards Bogor; 0.46 on a morning working day towards Jakarta; 0.62 on an Afternoon Weekday towards Bogor; 0.54 on Afternoon Workdays towards Jakarta; 0.50 on a morning holiday towards Bogor; 0, 40 on a morning holiday towards Jakarta; 0.74 on an Afternoon Holiday towards Bogor; 0.59 on Afternoon Holidays towards Jakarta. The results of comparisons before and during the Covid-19 pandemic show that there has been a decrease in the degree of saturation caused by the reduced volume of traffic flow during the Covid-19 pandemic.
2. Based on the results of the analysis of accident-prone locations in the Bogor Regency Regional Government Road Area in 2016 - March 2020 using the Accident Equivalent Rate (AEK), Upper Control Limit (BKA), and Upper Limit Control (UCL) method, it is concluded that Jalan Raya Bogor with an AEK value of 650 , Jalan Raya Sukahati Karadenan with an AEK value of 534, and Jalan Tegar Beriman with an AEK value of 250 where the BKA value is only 264,910 and the UCL value is 266,839 on Jalan Tegar Beriman, 266.5 on Jalan Raya Sukahati Karadenan, and 249,277 on Jalan Tegar Have faith. These roads are categorized as roads prone to traffic accidents, because they have an AEK score that exceeds or is greater than the BKA and UCL scores.
3. The factors causing traffic accidents in the Bogor Regency Regional Government Road Area in 2016 - March 2020 include:
   a. The driver's factor is the most dominant cause of accidents with a percentage of 35.52% with the majority of motorists who do not have orderly traffic.
   b. Lack of facilities for pedestrians such as zebra crossings to cross the road, the color of road markings and sidewalks is faded, the road surface has lots of holes or puddles and patches of holes that arise, and there are several road points that are not exposed to lighting are additional factors that can trigger an accident.
4. Solutions and handling of traffic accidents in the future area of the Bogor Regency Regional Government, namely:
   a. Installing and repainting road markings, zebra crossings, sidewalks or curbs according to the function and placement as needed on Jalan Raya Bogor
   b. Perform periodic surveillance work on Jalan Raya Bogor to prevent road damage that may result in traffic accidents.

5.2 Suggestions

1. There are improvements to Jalan Raya Bogor and Jalan Tegar Beriman including: Making zebra crossings for pedestrians, repainting road and sidewalk markings, repairing potholes, adding supporting signs, cutting trees that block street lighting, and checking periodically the street lights that are already dim or dead / not working.
2. Additional analysis needs to be done to complement secondary data such as the coordinates of each accident, the number of vehicles involved, weather, gender and age of the victim. And other methods can also be used in determining accident-prone points in the Bogor Regency Regional Government Road Area to get more accurate results.

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Biography

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