Analysis of Traffic Accident Using the Accident Equivalent Number (EAN) Method and Upper Control Limits on Serang Road Km 23 – Km 35 Tangerang Regency

K A Azalia[1], Sindriany[2] and Nabila[3*]

[1,2,3] Department of Civil Engineering, Mercu Buana University, Jakarta, Indonesia
*Corresponding author: nabila@mercubuana.ac.id

Abstract. Serang Road which is classified as a national road has a fairly high accident risk. Based on data from the Tangerang District Police for 2018-2022, it was found that the black site area is located at KM 23 – KM 35. It is necessary to identify the causes of the high number of accidents and solutions to reduce the number of accidents in that area. This study uses the Equivalent Accident Number (EAN) method, Upper Control Limit (UCL). The black site area from KM 23 – KM 35 with a total road length of 12 KM is divided into 12 observation Segments. Furthermore, sections identified as blackspots will be analyzed for road performance by referring to the 1997 Indonesian Road Capacity Manual (MKJI) and Guidelines for Handling Accident-Prone Locations (Pd-T-09-2004-B). The results of this study show that Segment 12 which is at KM 34 – KM 35 is a blackspot with the highest EAN value of 450 and exceeds the Upper Control Limit (UCL) value of 247,513 and the Upper Control Limit (BKA) of 252,187. If seen from the existing conditions in this Segment, with the 4/2UD road type located in industrial and commercial areas on both sides of the road, the service level is A (DS = 0.25) and the actual average speed is 50 km/hour, then this Segment potential for an accident. Especially in the time range 18.00-00.00 with the highest cause is a violation of the speed limit and is supported by the lack of lighting at night.

Keywords: Traffic Accidents, Black Site, Blackspot, Equivalent Accident Number, Upper Control Limit

Introduction

A traffic accident is an unexpected and unintentional event involving human casualties and or loss of property. (Law No. 22 of 2009). One of the causes of the high rate of traffic accidents is the lack of public awareness of driving. The condition of the driver's unpreparedness in driving allows accidents to occur which can endanger the safety of other road users. Tired, sleepy, less skilled, not keeping distance, going too fast are examples of common driver mistakes. In addition to these causes, the occurrence of traffic accidents on the highway is also influenced by the driver's age. (Ochtavia & Fikriah, 2018)

Balaraja Sub-district is one of the sub-districts in Tangerang Regency which has quite a lot of population density with various land uses such as factories, schools, offices, shops/shops, markets and residential areas. The increase in population was accompanied by an increase in traffic on the Roads of Tangerang Regency. Among them is Serang Road KM 23 – KM 35 which is one of the roads with a fairly high traffic volume. In addition to the many road users that pass through the road, the Serang main road is also passed by heavy vehicles, the majority of which are loaded for industrial purposes.

In addition, the road hierarchy and maintenance authority for the Serang Highway are classified as primary roads and include national roads, so they are considered to have a high enough risk of accidents that they can be said to be accident-prone areas.

RESEARCH METHODS

This research was conducted with two calculations, namely identification of accident-prone areas

and road performance. Of the two calculations, the first to do is Analysis of Accident-Prone Areas whose data processing includes the Equivalent Accident Number (EAN), Upper Control Limit (BKA/UCL), identification of accident-prone locations, identification of accident-causing factors, identification of proposed treatment in the area the accident. After the Accident-Prone Area Identification process has been completed, data processing on Road Performance is carried out by taking into account the data obtained from the previous survey. The survey procedures and data processing follow MKJI 1997 for Outer City Roads, namely taking into account free flow speed, road capacity, degree of saturation, travel speed, traffic behavior and level of service with the data obtained in the form of vehicle volume and capacity.

RESULTS AND ANALYSIS

The data obtained from the Tangerang District Police is in the form of accident recapitulation data from 2018 – 2022, including accident data or incidents, accident victim fatality data, accident time data, accident data based on the vehicles involved, factors causing traffic accidents and material losses due to accidents traffic.

Based on the accident data in Table 1, it is known that the area where accidents often occur is Segment 12 which is at KM 34 – KM 35 with 39 cases. Followed by Segment 2 with 23 cases, then Segment 10 with 21 cases. While the 3 Segments with the lowest number of accident cases were Segment 9 with 7 cases, Segment 5 with 9 cases and Segment 7 with 10 cases.

Table 1. Accident Data

No	Segment	Sta		Number of cases
		Starting	Ending	
1	Segment 1	23+000	24+000	14
2	Segment 2	24+000	25+000	23
3	Segment 3	25+000	26+000	16
4	Segment 4	26+000	27+000	13
5	Segment 5	27+000	28+000	9
6	Segment 6	28+000	29+000	17
7	Segment 7	29+000	30+000	10
8	Segment 8	30+000	31+000	18
9	Segment 9	31+000	32+000	7
10	Segment 10	32+000	33+000	21

No	Segment	Sta		Number of cases
		Starting	Ending	
11	Segment 11	33+000	34+000	9
12	Segment 12	34+000	35+000	39
Total Case 2018-2022				**199**

Source : Data Analysis, (2023)

Based on the fatality data for accident victims in Table 2, it is known that the death toll has increased from 2018 to 2019 and has decreased the following year but has increased again in 2022. Unlike the victims of serious injuries which tend to continue to decrease from year to year however, it has increased again in 2021 and 2022. As for the victims of minor injuries, it has increased from 2018 to 2019 and has decreased in the following year (Figure 1).

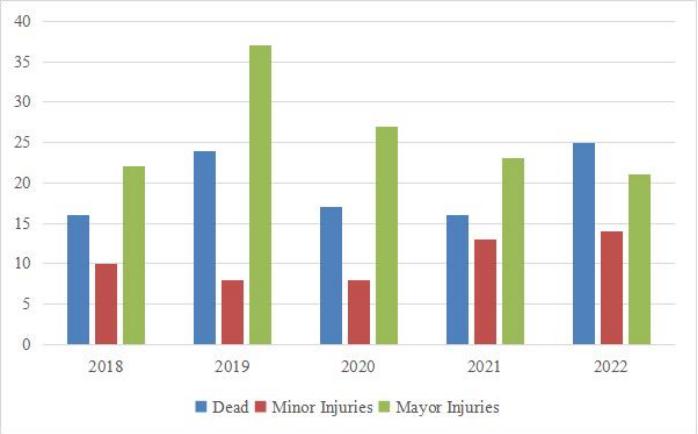


Figure 1. Chart of Accident Victim Fatality Data
Source: Data Analysis, (2023)

Source: Tangerang District Police (2022) Based on the data on the time of accident occurrence in table 3, it is known that 18.00 - 00.00 WIB is the time of occurrence of accidents with the highest number of incidents with a total of 72 incidents from 2018 to 2022.

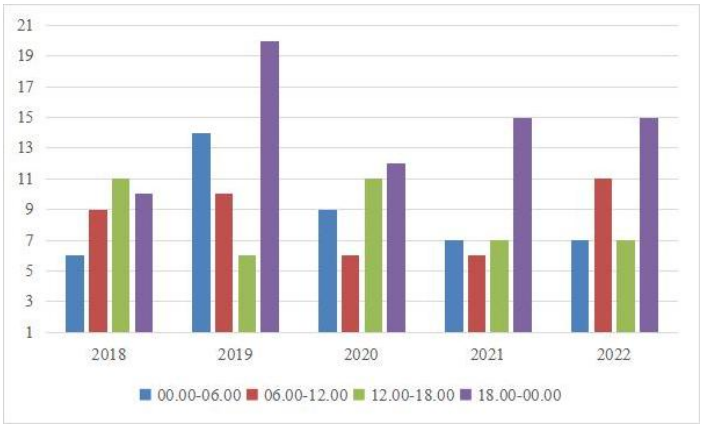


Figure 2. Chart of Accident Time Data
Source: Data Analysis, (2023)

Based on accident data based on vehicles in Table 4, it is known that motorcycles were the vehicles most involved in accidents, namely 196 incidents, followed by goods cars with 67 incidents and passenger cars with 14 incidents. For the classification of the types of vehicles involved, there are 6 classifications of vehicles including trucks >10 tonnes. However, on Jalan Raya Serang KM 23 – KM 35 there were no accidents involving them.

Figure 3. Chart of Accident Data Based on the Vehicles Involved
Source: Data Analysis, (2023)

Based on the data on the causes of traffic accidents in Table 2, it is known that the factor causing the highest traffic accidents is the precedence with 50 incidents. For the classification of other causative factors, namely in the form of failed brakes, heavy rain and smog or smoke, there were also 50 incidents.

Table 2 Data on the Causes of Traffic Accidents

No	Causative Factor	Year of the accident					Total
		2018	2019	2020	2021	2022	
1	Overtaking	10	15	11	8	6	50
2	Switch Lane	1	10	3	2	4	20
3	Safety Lane	11	4	3	0	4	22
4	Turn	4	7	3	7	6	27
5	High Speed	3	1	0	0	3	7
6	Damaged Road	0	0	1	0	0	1
7	Accident Between Human and Vehicle	1	5	2	7	4	19
8	Etc (Brake failure, Heavy Rain, Smog or Smoke	8	11	12	6	13	50
Total Accident 2018-2022		**38**	**53**	**35**	**30**	**40**	**196**

Source: Data Analysis, (2023)

Based on data on material losses due to traffic accidents in Table 3, it is known that Segment 6 is the Segment with the first highest amount of material losses due to accidents of Rp. 86,800,000 and Segment 1 which is ranked 2nd with the highest amount of material losses, namely Rp. 79,050. 000. This can happen because it involves expensive vehicles or damage to buildings on site.

Table 3. Material Loss Data Due to Traffic Accidents

No	Segment	Station		amount of loss		
		Starting	Ending	Material Loss		Amount
1	Segment 1	23+000	24+000	14	Rp	79.050.000,00
2	Segment 2	24+000	25+000	23	Rp	16.550.000,00
3	Segment 3	25+000	26+000	16	Rp	11.000.000,00
4	Segment 4	26+000	27+000	13	Rp	33.000.000,00
5	Segment 5	27+000	28+000	9	Rp	4.950.000,00
6	Segment 6	28+000	29+000	17	Rp	86.800.000,00
7	Segment 7	29+000	30+000	10	Rp	8.700.000,00
8	Segment 8	30+000	31+000	18	Rp	13.200.000,00
9	Segment 9	31+000	32+000	7	Rp	3.800.000,00
10	Segment 10	32+000	33+000	21	Rp	17.000.000,00
11	Segment 11	33+000	34+000	9	Rp	3.200.000,00
12	Segment 12	34+000	35+000	39	Rp	33.350.000,00
Total Loss from 2018-2022					**Rp**	**310.600.000,00**

Source: Data Analysis, (2023)

Calculations using the Equivalent Accident Number (EAN), Upper Control Limit (BKA/UCL) method were performed to determine the black site. An area can be said to be a black site if the EAN value exceeds the BKA/UCL value. Based on Table 4, it is known that the Equivalent Accident Number (EAN) value in Segment 12 is the highest value, namely 450 and the Upper Control Limit (UCL) is 247,513. Then Segment 10 the value of the Equivalent Accident Number (EAN) is 351 and the Upper Control Limit (UCL) is 243,017. Based on these results, it can be determined that the black site at the research case study location is Segment 12 which will be examined for road performance in the form of vehicle volume, vehicle speed and road inventory (Figur 4).

Table 4. Calculation of Identification of Accident-Prone Locations

No	Segment	Station		Value					
		Starting	Ending	EAN	C	BKA	λ	Ψ	UCL
1	Segment 1	23+000	24+000	104					227,766
2	Segment 2	24+000	25+000	308					240,871
3	Segment 3	25+000	26+000	154	208,833	252,187	208,833	2,576	231,637
4	Segment 4	26+000	27+000	151					231,421
5	Segment 5	27+000	28+000	117					228,835
6	Segment 6	28+000	29+000	245					237,444

No	Segment	Station		Value					
		Starting	Ending	EAN	C	BKA	λ	Ψ	UCL
7	Segment 7	29+000	30+000	169					232,686
8	Segment 8	30+000	31+000	258					238,183
9	Segment 9	31+000	32+000	100					227,426
10	Segment 10	32+000	33+000	351					243,017
11	Segment 11	33+000	34+000	99					227,341
12	Segment 12	34+000	35+000	450					247,513

Source: Data Analysis, (2023)

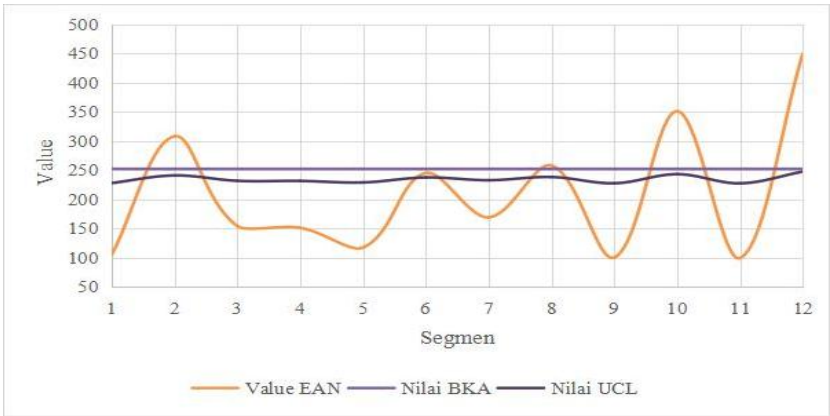
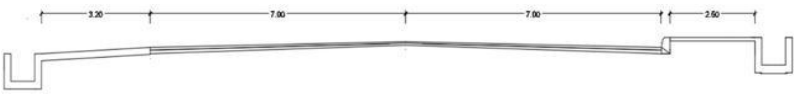


Figure 4. Graph Comparison of EAN, BKA, UCL
Source: Data Analysis, (2023)

Based on data from the Tangerang District Police, the point where accidents often occur is in front of the Jayanti gas station (KM 34.5) with the most occurrences occurring between 21.00 – 22.00 so that the data can be used as a reference for conducting a survey. The data obtained from these observations include the cross-sectional conditions of the road, vehicle volume, vehicle speed and road performance. Based on the data obtained, then the calculation of traffic flow, side friction class, free flow speed, road capacity, degree of saturation, travel speed, traffic behavior is carried out based on the 1997 Indonesian Road Capacity Manual (MKJI).



	Sisi A	Sisi B	Total	Rata-rata
Lebar jalur lalu lintas rata-rata	7 m	7 m	14 m	7 m
Kereb (K) atau Bahu (B)	B	K		
Jarak Kereb-penghalang	-	-	-	-
Lebar efektif bahu (dalam+luar)	3,2 m	2,5 m	5,7 m	2,85 m

Figure 5. Cross Section Existing Conditions
Source: Data Analysis, (2023)

The results of observations on the volume of vehicles crossing Segment 12 on Jalan Raya Serang KM 34 – KM 35 are shown in table 8. At 21.00 – 22.00 the total number of vehicles passing from Balaraja were 1889 vehicles consisting of 251 (13.29%) light vehicles, 163 (8.63%) heavy vehicles and 1475 (78.08%) motorcycles. Meanwhile, from the direction of Jayanti, a total of 1967 vehicles passed, consisting of 226 (11.49%) light vehicles, 155 (7.88%) heavy vehicles and 1586 (80.63%) motorcycles (Table 5).

Table 5. Complete Calculation of Total Flow Data (Q) Segment 12

Vehicle Type	**Light Vehicle**		**Heavy Vehicle**		**Motorcycle**				
emp arah 1	**LV :**	**1**	**HV :**	**1,2**	**MC :**	**0,25**	**Total FLow (Q)**		
emp arah 2	**LV :**	**1**	**HV :**	**1,2**	**MC :**	**0,25**			
Traffic	**vhc/ hr**	**vhc/ hr**	**vhc/ hr**	**vhc/ hr**	**vhc/ hr**	**smp/ hr**	**Traffic (%)**	**vch/ hr**	**smp/ hr**
1	251	251	163	195,6	1475	368,75	50	1889	815,35
2	226	226	155	186	1586	396,5	50	1967	808,5
1+2	**477**	**477**	**318**	**381,6**	**3061**	**765,25**	**100**	**3856**	**1623,85**
					Sp = $Q_1/(Q_{1+2})$			50	
					Smp factor, Fsmp =				0,42

Source: Data Analysis, (2023)
*LV = Light Vehicle, HV = Heavy Vehicle, MC = Motorcycle
*vhc/hr = vehicle per hour
*smp/hr = smp (satuan mobil penumpang (light vehicle unit)) per hour
*Sp = Traffic Flow Separator

Based on Table 6, it is known that the study location has a class of side barriers as an industrial area with shops on the side of the road and is classified as a class of medium side barriers (M). Determination of side resistance classes is based on MKJI 1997.

Table 6. Determination of Side Resistance Class

Frequency weighted occurrence	**Special Conditions**	**Side Obstacle Class**	
<100	Residential areas, almost no activity	Very Low	VL
100-299	Residential areas, some public transport etc	Low	L
300-499	**Industrial area with shops on the side of the road**	**Middle**	**M**
500-899	Commercial area with high roadsidactivity	High	H
>900	Commercial areas and road side market activity are very high	Very High	VH

Source: Data Analysis, (2023)

The Serang Road KM 34 – KM 35 section has a fairly good pavement and road geometric condition. This makes the riders become complacent and less concentrated. Coupled with the many pedestrians walking beside or crossing the road, making it possible for accidents to occur at that kilometer. Jalan

Raya Serang KM 34 – KM 35 with industrial area conditions with shops on the side

of the road, medium side resistance class (M). Based on Table 7, it can be seen the completeness of safety indicators.

Table 7. Completeness of Safety Indicators.

No	Safety Indicator	Completeness		Information
		Yes	No	
1	Road Signs	✓		Road signs are no longer suitable
2	Road Marking	✓		Road markings are faded at several points on the road. Lack of zebra crossing
3	Damaged Road		✓	Road conditions are good
4	Street Lights	✓		Along segment 12 there are only 2 street lights so it is still considered minimal lighting

Source: Data Analysis, (2023)

Based on Table 8, it is known that the actual speed of using a speed gun on Jalan Raya Serang KM 34 – KM 35 at 21.00 – 22.00 obtained the actual average speed of motorcycles of 50 km/hour, private cars of 43 km/hour and trucks of 34.5 km/hour.

Table 8. Actual Speed

Speed	Time survey	Distance (km)	Motorcycle Speed (km/hour)	Light Vehicle (km/hour)	Truck Speed (km/hour)
Vehicle 1	21.00-21.15	1	48	38	37
Vehicle 2	21.15-21.30	1	55	48	33
Vehicle 3	21.30-21.45	1	54	41	30
Vehicle 4	21.45-22.00	1	43	45	38
Average TMS			50	43	34,5

Source: Data Analysis, (2023)

Based on the secondary data, it is not clear what the Segment division for the 1 km range is. However, based on data obtained from the Tangerang District Police, the most accident locations were around the Jayanti gas station. So that the primary survey location is around the Jayanti gas station with a range of 100 m before and 100 m after the Jayanti gas station. Based on table 12, it is known that motorbike drivers drive their vehicles in excess of the operational speed of >50 km/hour (Table 9).

Table 9. Calculation Recapitulation Results

Volume (smp/hour)	Capacity (smp/hour)	Deegre of Saturated (DS)	Speed (V_{LV}) (km/hour)	Actual Speed (km/hour)
1623,85	6392	0,25	39	50

Source : Data Analysis, (2023)

CONCLUSION

Based on the results and analysis of traffic accidents and their handling using the EAN and BKA/UCL methods to determine accident-prone areas, it can be concluded: a. The cause of the high number of accidents at accident-prone points is the lack of lighting on Segment 12 which is 1 km long, only has 2 lights and drivers often overtake other vehicles. b. After analyzing the calculation of identification of accident-prone locations on Jalan Raya Serang, a black site was obtained, namely in Segment 12 with an Equivalent Accident Number (EAN) value of 450, BKA of 252,187 and UCL of 247,513. c. The blackspot location (around SPBU Jayanti) has quite good pavement and road geometric conditions. This makes the riders become complacent and less concentrated. Blackspot location with industrial area conditions with shops on the side of the road, medium side obstacle class (M). d. The best solution and handling of traffic accidents that occur on Jalan Raya Serang in the future is by providing caution signs and warning signs that drivers are at accident-prone points, providing Road lighting every 40 m and installing and repainting road markings and zebra crossings.

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