

Analysis of Determining the Location of Blackspots and Black Sites on the Bypass Road KM 19-27 Padang City using the Accident Equivalent Number and Upper Control Limit Method

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ABSTRACT

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The Padang City Bypass Road KM 19-27 is a road section that has quite a heavy traffic volume, starting from the Lubuk Minturun intersection to the Flyover towards the Airport, so there is a high possibility of accidents occurring along this road section. This research uses secondary data obtained from the Unit Padang City Police Traffic Accident. This research aims to determine the characteristics of traffic accidents and identify locations prone to accidents on the Padang City KM 19-27 Bypass Road during the 2018-2022 period and to provide alternatives for preventing traffic accidents in the future. This type of research uses the Accident Equivalent Number (AEK) method and the Upper Control Limit (UCL) method. If the AEK value is greater than the UCL then it is categorized as an accident-prone location. The results of the analysis of the characteristics of traffic accident data for 2018-2022, the highest was at KM 20 with 16 incidents, based on time, namely 07.00-08.00 WIB, 10 incidents, based on victims, namely minor injuries (LR), 161 victims, and based on causal factors. The main cause of traffic accidents is the human factor. Blackspot location based on analysis using the AEK method with 5 years of data (2018-2022), namely at KM 20 with the highest total AEK value, namely 221. The black site location using the AEK method with UCL control limits on the Padang City Bypass Road section KM 19-27 is KM 19, 20, 21, 22, 23, 24 and 25. Recommendations for handling traffic accidents on the Padang City Bypass KM 19-27 road, namely by providing education about driving safety, checking vehicles regularly, improving the physical condition of the road and prohibiting pedestrians from walking. at certain points that disrupt traffic.

Keywords: Accident characteristics, Upper control limit, Accident equivalent number, Blackspot, Black site

1. Introduction

Based on traffic accident data from the Padang City Police, West Sumatra (Sumbar), it was recorded that the number of traffic accident cases in Padang City increased from 2017 to 2021. From January to November 2018, there were 614 accident cases, while data from January to December 2017 was 576 cases. Of the 614 cases, at least 1,019 people died, 60 people died, 98 people were seriously injured, and 861 people had minor injuries. Material losses due to the accident were recorded at more than IDR 800 million [1]. Meanwhile, of the 576 incidents recorded in 2017, the number of fatalities was 1,047 people, consisting of 51 people who died, 333 people were seriously injured, and 663 people were slightly injured. Material losses due to this incident amounted to IDR 1.2 billion [1]. The types of violations committed by drivers are not wearing a helmet, wearing a helmet that does not comply with Indonesian National Standards (SNI),



driving against the flow of traffic, not completing driving documents, and underage drivers not having a driving license. Driving License (SIM). Bypass Road in Padang City is the main alternative road which has quite dense normal traffic with a very high level of traffic development because it is used by local areas for activities because of its easy access to accommodation and the center of the capital and for certain areas it is an indirect choice because shorten travel time [2].

Accidents are one of the main causes of death worldwide. WHO estimates that the death rate due to traffic accidents worldwide reaches 2.4 million/year in people aged 30-44 years, this number ranks third behind the death rate due to HIV/AIDS infection and tuberculosis (TB) [1]. The large number of victims will cause quite large economic (physical damage) and social impacts. The increasing number of vehicles and low public awareness of driving causes traffic accidents [3], [8], [9].

A traffic accident is an incident that occurs suddenly and unintentionally on the road. Starting from minor traffic accidents that do not cause death, to serious traffic accidents that result in death, due to careless and reckless drivers that cause fatal accidents [4]. In 2019-2021, traffic accidents occurred on the bypass road in the Padang city area towards Teluk Bayur - BIM, there were 51 traffic accidents in 2019, 38 traffic accidents occurred in 2020 and 47 incidents occurred in 2021. With a total of 19 incidents, injuries 22 people had serious injuries, and 141 people had minor injuries [5]. The number of traffic accidents in Padang City is still very high and needs to be handled seriously. Accidents occur in many locations with different incident times, making it difficult to identify areas where traffic accidents frequently occur. The public and law enforcement officials need information about accident-prone areas. This information can be used to consider monitoring and prediction activities, especially for the police [6], [7], [10].

Because accidents often occur on this road. It is necessary to conduct research into the causes of frequent accidents on this road section so that in the future the causes of these accidents can be addressed, thereby increasing the number of accidents and the number of victims injured as a result of accidents. Therefore, this article will analyze the factors behind the accident that occurred on the KM 19-27 Bypass Road, Padang City. So that in the future the number of accidents can be reduced so that there are no more accident victims.

2. Research methods

The research location is the Padang City Bypass Road, with the starting point at Simpang Lubuk Minturun and the ending point at the Flyover in the direction of the Airport. This road is 9 KM long. This research data is secondary data obtained from the Padang City Police Traffic Accident Unit. The data that will be taken is accident data from 2018-2022 which includes the time of the accident, number of victims and location of the accident.

In processing the data in this research what will be analyzed are:

1. Identify the cause of the accident
2. Identify locations of accident-prone points (blackspots) using the Accident Equivalent Number (AEK) method.

Formula AEK as follows:

$$AEK = (12 \times MD) + (3 \times LB) + (3 \times LR) \quad (1)$$

with:

AEK: Equivalent Accident Number LB: Serious Injuries
MD: Died LR: Minor Injuries

3. Identify accident-prone areas (*Blacksite*) by comparing the AEK (*Accident Equivalent Number*) value with the UCL (*Upper Control Limit*) control limit value.

formula developed by Norden & Orlansky:

$$UCL = \lambda + \Psi \times \sqrt{([\lambda / m] + (0.829)/m + (1/2 \times m))} \quad (2)$$

with:

λ : Average number of accidents Ψ : Probability factor 2.576
m : Accident rate for the section under review (AEK)

The value of the probability factor (Ψ) that is often used is 2.576 with a probability of 0.005 (or a significant value of 99.5%).

- After obtaining the results, conclusions can be drawn so that recommendations can be made to minimize accidents that occur on the Padang City KM 19-27 Bypass Road.

3. Results and discussion

Based on established research methods, analysis was carried out to determine the location of the Black site and Blackspot in the Km19-Km27 Bypass Road area of Padang City.

3.1 Data on the number of accidents that occurred on the KM 19 – KM 27 Bypass Road, Padang City in 2018-2022

The number of general traffic accidents on the Km19-27 bypass from 2018 to 2022, this analysis aims to determine the characteristics, accident-prone areas (black spots), and accident-prone locations (black sites) and evaluate the extent to which traffic accidents occur [7].

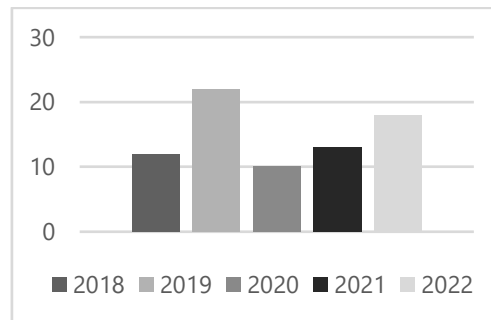


Figure 1. Number of accidents that occurred in 2018-2022

3.2 Number of accident victims based on type of victim

The characteristics of accidents based on the type of victim on the Padang City Bypass Road were carried out using victim type parameters, namely: deaths (MD), serious injuries (LB) as many people, and light injuries (LR) [7].

Table 1. Number of accident victims in 2018-2022

No	Year	MD	LB	LR
1	2018	4	2	30
2	2019	11	2	47
3	2020	0	7	18
4	2021	10	0	34
5	2022	8	6	36
Total		33	17	165

3.3 Number of traffic accidents based on time of event

Time characterization of accidents that occurred on the Padang City KM 19-27 Bypass was carried out using hourly time parameters for 24 hours [7].

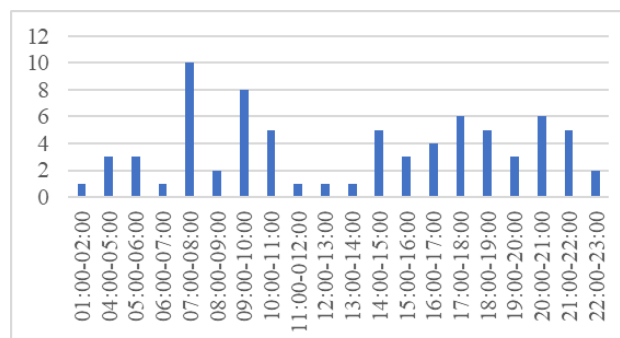


Figure 2. Time pattern of accidents in 2018-2022

3.4 Number of traffic accident victims based on location of incident

The *Blackspot* location is on the Bypass Road, namely at KM 20, where a total of 16 accidents occurred over the last 5 years, from 2018 to 2022 [7].

Table 2. Accident data per kilometer for 2018-2022

KM	Year					Total
	2018	2019	2020	2021	2022	
19	3	4	2	2	3	14
20	2	8	0	3	3	16
21	3	0	1	2	4	10
22	0	1	3	1	1	6
23	2	2	1	1	1	7
24	2	3	1	3	4	13
25	0	2	2	1	0	5
26	0	1	0	0	0	1
27	0	1	0	0	2	3
TOTAL	12	22	10	13	18	

3.5 Factors causing accidents

The biggest cause of accidents on the KM 19 to 27 Bypass Road section was due to human factors, namely 74 accidents. Of all the factors causing accidents, a total of 92 accidents occurred from 2018 to 2022 at kilometers 19-27 Jl. Padang City Bypass [7].

Table 3. Recapitulation of causes of traffic accidents in 2018-2022

No	Causes of Accidents	Year					Total
		2018	2019	2020	2021	2022	
Human Factors							
1	Less focus	7	11	7	5	9	40
2	Forbidden	2	0	0	0	0	2
3	Not Careful Crossing the Road	1	1	0	2	0	5
4	Running a Red Light	0	0	0	0	0	0
5	High speed	3	4	7	5	8	28
6	Cutting Under Force	1	0	0	0	0	1
7	Less Parking Vehicles to the Left	1	1	0	0	0	2
8	Violating Traffic Wednesday	0	0	0	0	0	0
9	Change lanes less carefully	2	0	0	1	0	3
Vehicle Factors							
1	Lost control	0	7	2	1	3	13
2	Damaged	1	0	0	0	0	1
3	No turn signal	0	0	0	1	1	2
4	Tire burst	0	1	0	0	0	1
5	Without Explanation	0	0	0	0	0	0
Road Factor							
1	Damaged roads	0	1	1	1	0	3
Environmental factor							
1	Visibility	0	0	0	0	0	0

3.6 Accident prone location points based on field survey results

Sourced from Padang Police Accident Data, the cause of the accident at this location was a minibus (running) coming from the north to the south or coming from the direction of Parak Bad towards the Koto Pulai intersection. the same direction. The motorbike was going from the north to the south or coming from the Parak Buruk Bypass intersection towards the Koto Tuo Bridge, when they arrived at the location, they were hit by a motorbike in front of them coming from the same direction [7].



Figure 3. Locations prone to accidents on the KM19 Bypass Road in Padang City

3.7 Calculation of Accident Equivalent Figures (AEK)

Based on the analysis carried out with total data used for 5 years, namely 2018 to 2022 on the Padang City Bypass Road KM 19-27, the results showed that the highest total AEK (Accident Equivalent Number) was at KM 20 with a total AEK value of 221, and the lowest AEK value is KM 26 with the total AEK value for 5 years being 32. It can be concluded that the *Blackspot location point* on the Padang City Bypass Road Km 19-27 is at KM 20.

3.8 Calculation of Upper Control Limit (UCL)

Table 4. Control AEK values using the *Upper Control Limit* (UCL) method in 2018-2020

KM	2018			2019			2020				
	λ (Average AEK)	AEK	UCL	KM	λ (Average AEK)	AEK	UCL	KM	λ (Average AEK)	AEK	UCL
19	17,2	30	27	19	42,3	77	58	19	10,0	14	17
20	17,2	11	24	20	42,3	123	63	20	10,0	0	0
21	17,2	38	27	21	42,3	0	0	21	10,0	7	16
22	17,2	0	0	22	42,3	8	50	22	10,0	39	21
23	17,2	58	31	23	42,3	29	53	23	10,0	7	16
24	17,2	18	25	24	42,3	64	57	24	10,0	8	16
25	17,2	0	0	25	42,3	17	51	25	10,0	15	17
26	17,2	0	0	26	42,3	32	53	26	10,0	0	0
27	17,2	0	0	27	42,3	31	53	27	10,0	0	0
TOTAL		155	135			381	438			90	104

Table 5. Control AEK values using the *Upper Control Limit* (UCL) method in 2021-2022

KM	2021			2022			
	λ (Average AEK)	AEK	UCL	KM	λ (Average AEK)	AEK	UCL
19	20,4	42	32	19	28,7	58	43
20	20,4	44	33	20	28,7	43	41
21	20,4	16	28	21	28,7	65	43
22	20,4	7	27	22	28,7	7	36
23	20,4	17	28	23	28,7	17	37
24	20,4	29	30	24	28,7	35	40
25	20,4	29	30	25	28,7	0	0
26	20,4	0	0	26	28,7	0	0
27	20,4	0	0	27	28,7	33	39
		184	210			258	279

Upper Control Limit/control limit value with data for 5 years, it was found that the areas with high accident rates (Black site) were at KM 19, 20, 21, 22, 23, 24 where at that kilometre the AEK value exceeds the control limit or exceeds the UCL value. Meanwhile, in 2018 it was at KM 19, 21 and 23. In 2019 it was at KM 19, 20 and 24. In 2020 it was at KM 22. In 2021 it was at KM 19 and 20. And in 2022 it was at KM 19, 20 and 21.

3.9 Handling recommendations

1. Human factors

Several solutions that can be taken to minimize the occurrence of accidents caused by human factors.

- a. Provide education about driving safety
- b. Use a helmet or seat belt when riding
- c. Always pay attention to existing traffic signs
- d. Always keep the distance between the vehicle and other vehicles
- e. Do not use or stay away from your cell phone while driving
- f. Don't feel sleepy when driving
- g. Driving at high speed is prohibited

2. Vehicle factors

The following are several solutions that can be taken to minimize the occurrence of accidents caused by vehicle factors.

- a. Always check the vehicle regularly
- b. Using SNI equipment on vehicles
- c. Carrying transport or goods should not exceed the maximum capacity

3. Road condition factors

The following are several solutions that can be implemented to minimize the occurrence of accidents caused by road geometric factors.

- a. Improve road physics
- b. Installation of clearer and more complete signs
- c. Repair traffic signs

4. Environmental factor

The following are several solutions that can be taken to minimize the occurrence of accidents caused by environmental factors

- a. Do not park your vehicle on the road, because it can interfere with moving vehicles.
- b. Pedestrians are prohibited from walking at certain points that could disrupt traffic.

4. Conclusions

By carrying out several calculations and analysis of traffic accident data, it can be concluded:

1. Traffic accident victims based on the type of victim on the Padang City Bypass KM 19-27 road were found to have the highest number of victims with minor injuries (LR), namely 165 people in the last 5 years (2018-2022). Then, based on the time of occurrence, accidents most often occur at 07:00 – 08:00 with 10 total accidents based on 5 years of data analyzed, where this hour is peak hour on the Bypass Road so the possibility of accidents occurring will be greater.
2. The main cause of traffic accidents on the Padang City KM 19-27 Bypass Road is the human factor (human error), namely due to 7 things: high speed, unsafe first, not giving priority, violating APIL, violating markings, not keeping distance, and don't put a sign.
3. *Blakspot* location based on analysis using the Accident Equivalent Number (AEK) method with 5 years of vulnerable data (2018-2022) is at KM 20 which has the highest total AEK value, namely 221.
4. *Blacksite* locations using the Equivalent Accident Number (AEK) method with *Upper Control Limit (UCL)* control limits on the Padang City Bypass Road Km 19-27 per year are as follows:
2018 = KM 19, 21 and 23, 2019 = KM 19, 20, and 24, 2020 = KM 22, 2021 = KM 19 and 20 and 2022 = KM 19, 20 and 21
5. Recommendations for handling traffic accidents on the Padang City Bypass KM 19-27 road are as follows:
 - a. Provide education about driving safety.
 - b. Check the vehicle regularly.
 - c. Improve road physics.
 - d. Pedestrians are prohibited from walking at certain points that could disrupt traffic.

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