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Identification of Accident-Prone Points (Black Spots) on the Ujung Gading-Simpang Empat Road Section

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ABSTRACT

The Ujung Gading-Simpang Empat road section has the highest number of accidents in West Pasaman Regency. Accidents that occur at a location range from minor injuries to death. This research aims to determine the main factors influencing accidents, accident characteristics, and black spots and find solutions to minimize accidents. Research method, the method used is a quantitative descriptive method. Driver factors are the biggest factor causing accidents with 330 cases in 2018-2022. Apart from driver factors, vehicle factors also influence traffic accidents with 75 cases in the 2018-2022 period. Analysis of the Highest Accident Rate using the Accident Equivalent Number (AEK) method, and to calculate the number of accidents and the Upper Control Limit (UCL) method to determine accident-prone locations. The data used is the 2018-2022 West Pasaman Traffic Police traffic accident report data which is grouped based on characteristics. Based on the calculation results, the Ujung Gading-Sungai Aur road section has an AEK value of 1081 and UCL 1,036, Sungai Aur-Simpang Tiga Alin with an AEK value of 697 and UCL 884m26, and Simpang Tiga Alin-Simpang Empat with an AEK value of 690 and UCL 840.77. So these three roads are declared as accident-prone areas (black spots). To minimize the number of accidents, efforts are made by law enforcement (Enforcement), education (Education), and engineering (Engineering).

Keywords: *Black Spot; AEK; UCL; Factors Causing Accidents; Characteristics of Accidents.*

INTRODUCTION

West Pasaman Regency has one road section, namely the Ujung Gading-Simpang Empat highway. The Jalan Ujung Gading-Simpang Empat section is one of the connecting roads for people to Simpang Empat and the city of Padang. This road section is 50 km long, and passes through two sub-districts, namely Sungai Aur sub-district and Gunung Tuleh sub-district) and ends at Simpang Empat. The Ujung Gading-Simpang Empat road section has the highest number of accidents in West Pasaman Regency. Accidents that occur at a location range from minor injuries to death. The large number of victims will have a significant economic (material loss) and social impact, and various preventive efforts to improve traffic involving various related parties have not had the results expected. According to the West Pasaman Police Chief, traffic accidents on the Ujung Gading-Simpang Empat highway, West Pasaman Regency in 2022 recorded 393 accident cases, including the highest in West Sumatra.

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Handling carried out in areas prone to traffic accidents (black sites) on the Kapontori KM 76 – KM 82 axis road is repairing road markings, providing traffic signs, and providing road lighting, and in the future it is also necessary to deal with road geometric conditions such as curves less than 450 and other things related to road geometry [3]. Things that must be done to minimize the occurrence of traffic accidents are not only through physical improvements, such as repairing roads, building additional facilities, and installing warning signs but also psychologically among road users so that fewer people are violating existing traffic regulations, even lost [4]. To handle accident-prone locations where the accident rate is dominated at night, with side-impact collision types, the response to accident-prone locations is to provide medians, provide road markings for road sections that do not have markings, and provide maximum lighting so that it is not dangerous for road users. At night [5]. By determining accident-prone points, it is hoped that information can be used to improve road quality to support road safety in the aspect of road infrastructure [6]. Motorbikes are the vehicles most frequently involved in accidents, followed by passenger cars. Based on the location of the accident, the majority of accidents occur on inter-city roads and the main factor causing accidents is humans [7]. Accidents based on the factors causing accidents on Jalan Yos Sudarso Pekanbaru during the 2014-2018 period were most dominant in humans as a result of overtaking without calculation, crossing, and turning direction without looking at the situation [8].

The objectives of this research, in terms of the following, are:
1. To identify the main factors that influence traffic accidents on the Jalan Raya Ujung Gading-Simpang Empat, West Pasaman Regency.
2. To determine the characteristics of accidents on the Ujung Gading-Simpang Empat highway, West Pasaman Regency.
3. Determine accident-prone points (Black Spot).
4. To obtain a solution that can be used to minimize the number of traffic accidents that occur.

METHOD

Stages in this research
1. Preliminary survey at the research location.
2. Establish interview and field observation research methods
3. Data collection, consisting of:
   a. Primary Data.
      The research location is along the Ujung Gading-Simpang Empat highway, West Pasaman Regency. The primary data needed in this research are a visual condition of road pavement, data on the completeness of road facilities and infrastructure, and data on traffic volume.

   b. Secondary Data
      In this research, the secondary data needed is data on reports of traffic accidents that occurred during the last 5 years (2018-2022) from traffic accidents at the West Pasaman Police. For locations along the Ujung Gading-Simpang Empat highway, West Pasaman Regency, including time, location, gender of the perpetrator, type of vehicle involved in the traffic accident, and geometric data and map of the Ujung Gading-Simpang Empat highway, West Pasaman Regency.

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4. Data Processing and Analysis
The processing and analysis of this data is intended to obtain research results so that ways to prevent accidents and solutions to improve traffic safety can be formulated.

5. Conclusion
After carrying out data processing and analysis, conclusions can be drawn. The final step involves drawing conclusions that contain important things in accordance with the objectives to be achieved in the research.

RESULTS AND DISCUSSION

Factors Causing Accidents

Tabel 1. Factors causing traffic accidents

No	Factors Causing Accidents	Number of Accidents Per Year					Total
		2018	2019	2020	2021	2022	
1	Human Factors	54	66	55	67	88	330
2	Vehicles Factors	15	13	7	18	22	75
3	Road Factors	3	4	1	7	5	20
4	Vehicles Factors	2	3	2	6	11	24
Total		74	86	65	98	126	449

Based on Table 1 above, it can be seen that the factor causing the most accidents that occurred on the Ujung Gading-Simpang Empat road, West Pasaman Regency, from 2018-2022 was the human factor, or what is called the driver, with a total of 330 cases.

Accident Characteristics

To determine the characteristics of traffic accidents on the Ujung Gading-Simpang Empat Pasaman Barat road section, data was obtained from the West Pasaman Police. The number of traffic accidents on the Ujung Gading-Simpang Empat road section, West Pasaman Regency, from 2018 to 2022 has always increased. This increase occurred because the number of vehicle owners is increasing, but the development of roads and road facilities is still lacking. In addition, discipline in driving and pedestrians is still low, so it can also be the cause of the high number of accident cases on the Ujung Gading-Simpang Empat road section, West Pasaman Regency.

Tabel 2. Number of traffic accidents from 2018-2022

years	2018	2019	2020	2021	2022	Total
Number of Accidents	74	86	65	98	126	449

Based on Table 2 above, it can be seen that the number of traffic accidents on the Ujung Gading-Simpang Empat road section of West Pasaman Regency that occurred from 2018-2022 was 449 accident cases, with details in 2018 as many as 74 accident cases, in 2019 as many as 86 accident cases, in 2020 as many as 65 accident cases, in 2021 as many as 98 accident cases, and in 2021 as many as 126 accident cases.

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Tabel 3. Annual LHR (average traffic) data

No.	Years	Number of Vehicles
1	2018	19876
2	2019	16733
3	2020	11465
4	2021	18093
5	2022	23834

Accident Characteristics Based on Type of Victim

Tabel 4. Number of traffic accident victims based on type of victim

No	Types of Victims	Number of Accidents Per Year				
		2018	2019	2020	2021	2022
1	MD (Die)	6	2	3	5	4
2	LB (Serious Injury)	3	9	6	8	5
3	LR (Minor injuries)	92	111	94	127	144
Total		101	122	103	140	153

Based on Table 4, the number of traffic accident victims based on the type of victim can be seen in the following diagram: In 2018, 6 people died, 3 people were seriously injured, and 92 people were slightly injured; in 2019, 2 people died, 9 people were seriously injured, 111 people were slightly injured; in 2020, 3 people died, 6 people were seriously injured, 94 people were slightly injured, in 2021, 5 people died, 8 people were seriously injured, 127 people were slightly injured; in 2022, 4 people died, 5 people were seriously injured, 144 people were slightly injured.

Accident Characteristics Based on Day

Tabel 5. Traffic accident victims by day

No	Day	Number of accidents per year					Total
		2018	2019	2020	2021	2022	
1	Monday	10	15	6	15	25	71
2	Tuesday	12	12	9	17	17	67
3	Wednesday	9	15	12	8	15	59
4	Thursday	12	6	11	18	18	65
5	Friday	8	11	7	13	14	53
6	Saturday	13	15	5	11	21	65
7	Sunday	10	12	15	16	16	69
Total		74	86	65	98	126	449

Based on Table 5, it is concluded that accident victims based on days since 2018-202 are as follows:

1. In 2018, there were 74 accident cases, where on Monday there were 10 cases, Tuesday there were 12 cases, Wednesday there were 9 cases, Thursday there were 12 cases,

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Friday there were 8 cases, Saturday there were 13 cases, and Sunday there were 10 cases.

2. In 2019, there were 86 accident cases, where on Monday there were 15 cases, Tuesday there were 12 cases, Wednesday there were 15 cases, Thursday there were 6 cases, Friday there were 11 cases, Saturday there were 15 cases, and Sunday there were 12 cases.
3. In 2020, there were 65 accident cases, where on Monday there were 6 cases, Tuesday there were 9 cases, Wednesday there were 12 cases, Thursday there were 11 cases, Friday there were 7 cases, Saturday there were 5 cases, and Sunday there were 15 cases.
4. In 2021, there were 98 accident cases, where on Monday there were 15 cases, Tuesday there were 17 cases, Wednesday there were 8 cases, Thursday there were 18 cases, Friday there were 13 cases, Saturday there were 11 cases, and Sunday there were 16 cases.
5. In 2022, there were 126 accident cases, where on Monday there were 25 cases, Tuesday there were 17 cases, Wednesday there were 15 cases, Thursday there were 18 cases, Friday there were 14 cases, Saturday there were 21 cases, and Sunday there were 16 cases.

Accident Characteristics Based on Time of Incident

Tabel 6. Number of traffic accident victims based on time of incident

No	Hours	Number of Accidents Per Year					Total
		2018	2019	2020	2021	2022	
1	06:00 - 19:00	53	60	48	67	84	312
2	19:00 - 06:00	21	26	17	31	42	137
Total		74	86	65	98	126	449

Based on Table 6, above, it can be seen that accidents that often occur are during the day (06.00-19.00) with the number of accidents as many as 312 and at night (19.00-06.00) as many as 137. This shows that accidents during the day occur more often than at night because the number of vehicles during the day is much denser than at night, but it does not rule out the possibility of accidents occurring at night when traffic is quiet.

Accident Characteristics Based on Type of Vehicle Involved

Tabel 7. Number of vehicles involved in traffic accidents

No	Vehicle Type	Number of Accidents Per Year					Total
		2018	2019	2020	2021	2022	
1	Motorcycle	72	98	87	115	120	492
2	Private car	5	7	4	3	8	27
3	*Pick Up*	3	5	2	6	4	20
4	Bus	0	0	0	0	1	1
5	Bicycle	1	2	0	3	5	11
6	*Truck*	0	6	5	4	7	22
7	*Truck 3as*	0	0	0	0	3	3
8	Pedestrian	2	3	1	4	6	16
9	Etc	0	0	1	3	6	10
Total		83	121	100	138	160	602

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Based on Table 7, it can be concluded that the number of accidents based on the type of vehicle involved from 2018-2022 on the Ujung Gading-Simpang Empat road section, West Pasaman Regency, mostly occurred in motorcycles with 492 accidents, and the fewest were bicycles and 3-axle trucks with 0 cases.

Accident Characteristics Based on Age of Suspects and Victims

Tabel 8. Number of traffic accident victims by age

No	Age	Number of Accidents Per Year					Total
		2018	2019	2020	2021	2022	
1	< 7	4	8	3	11	14	40
2	7 – 9	9	5	4	6	24	48
3	10 – 15	19	23	16	12	25	95
4	16 – 30	23	32	27	22	46	150
5	31 – 40	17	16	15	28	23	99
6	41 – 50	8	11	11	17	12	59
7	> 51	5	8	2	14	11	40
Total		85	103	78	110	155	531

Based on Table 8, above, it is concluded that accidents on the Ujung Gading-Simpang Empat road section, West Pasaman Regency, not only occur among people aged 7-50, but also those aged > 51 who may experience traffic accidents even as pedestrians.

Accident Characteristics Based on the Type of Accident that Occurs

Tabel 9. Number of traffic accident victims based on the type of accident that occurred

No	Accident Type	Number of Accidents Per Year					Total
		2018	2019	2020	2021	2022	
1	Single accident	16	19	10	20	26	91
2	Hit a fixed object	8	12	3	17	23	63
3	Hit a pedestrian	2	3	1	4	6	16
4	Front-to-front collision	28	30	25	26	38	147
5	Front-to-rear collision	11	16	7	18	25	77
6	Front-to-side collision	9	15	10	16	19	69
7	Side-to-side collision	0	0	0	0	0	0
8	Multi-vehicle collision	0	0	0	0	0	0
Total		74	95	56	101	137	463

Based on Table 9 above, it can be seen that the accidents that frequently occur on the Ujung Gading-Simpang Empat road section, West Pasaman Regency, based on the type of accident that occurs, are front-to-front collisions, totaling 147 accidents.

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Accident Characteristics Based on Location and Number of Accidents

Tabel 10. Number of traffic accident victims based on location and number of accidents

No	Road section (Km)	Information	Number of Accidents Per Year					Total
			2018	2019	2020	2021	2022	
1	0 – 17	Ujung Gading-Sungai Aur	37	52	29	56	73	247
2	17- 31	Sungai Aur-Simpang Tiga Alin	23	16	21	23	32	115
3	31 – 50	Simpang Tiga Alin -Simpang Empat	14	18	15	19	21	87
Total			74	,86	65	98	126	449

Based on Table 10, above, it can be seen that traffic accidents on the Ujung Gading-Simpang Empat road section of West Pasaman Regency mostly occur at Km 0-17, namely at Ujung Gading-Sungai Aur.

Road Geometric Data

The Ujung Gading-Simpang Empat road section of West Pasaman Regency is one of the many areas prone to traffic accidents in West Pasaman. This road section is a connection to Simpang Empat and Agam Regency, so this area has quite a potential for traffic accidents. For more details on the geometric data on the Ujung Gading-Simpang Empat road section of West Pasaman Regency, see Table 11.

Tabel 11. Geometric Data of the Ujung Gading-Simpang Empat Road Section

A	Road Type	2/2 UD
B	Road Segment Length	50 Km
C	Lane Width	7 m
D	Lane Width	3,5 m
E	Median	none
F	Sidewalk	none
G	Road Markings	exist

Accident Prone Areas (Black Spots)

Analysis of the Highest Accident Rate Using the Accident Equivalent Number (AEK) Method

The accident equivalent number is calculated by adding up the accident incidents in one kilometer or one segment of road length, then multiplying it by the weight value according to the severity level. This method is used to analyze the highest accident rate (black spot) that occurs on the Ujung Gading-Simpang Empat road section of West Pasaman Regency. The Accident Equivalent Number (AEK) is a number for weighting accident classes [1].

Example of calculating the equivalent accident rate at: On the Ujung Gading-Sungai Aur road section:

$$AEK=12MD+3(LB+LR) + K \quad \text{……(1)}$$

$$= 12\ (9) + 3\ (15+227) + 247$$

$$= 1.231\text{person}$$

Analysis Determining the Upper Control Limit (UCL) Value

In determining accident-prone points, a statistical quality control method is used as a control-chart UCL (Upper Control Limit) which is based on the number of accidents per

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kilometer or road segment that has a weight value (AEK) exceeding the UCL limit value. Based on the calculation of the number of accidents from the accident equivalent number method, calculations can be made using the statistical quality control method on each segment on the Ujun Gading-Simpang Empat highway in West Pasaman Regency as below: The UCL Calculation Formula [2] can use the following equation:

$$UCL = \lambda + \Psi \times \sqrt{\left[\left(\frac{\lambda}{m}\right) + \left(\frac{0{,}829}{m}\right) + \left(\frac{1}{2}xm\right)\right]} \qquad \text{.....(2)}$$

Dimana : λ = Average accident rate AEK
Ψ = Probability factor 2,576
m = Accident rate for the section under

Example of Calculation on the Sungai Aur – Simpang Tiga Alin road section:
Given:

AEK value on the Ujung Gading road section = 1,081 Total AEK value = 2,468

Asked: Control Limit (UCL) Number Value?

Solution:
From the total number of Accident Equivalent Numbers = 2,468 in the 5-year research segment, the average value (λ) is as follows: λ = 2,468/5 = 493.6

Tabel 12. UCL Calculation Results 2018-2022

No	Road Section	AEK	UCL	Information
1	Ujung Gading - Sungai Aur	1.081	1.036	Accident prone
2	Sungai Aur - Simpang Tiga Alin	697	844,26	Accident prone
3	Simpang Tiga Alin - Simpang Empat	690	840,77	Accident prone

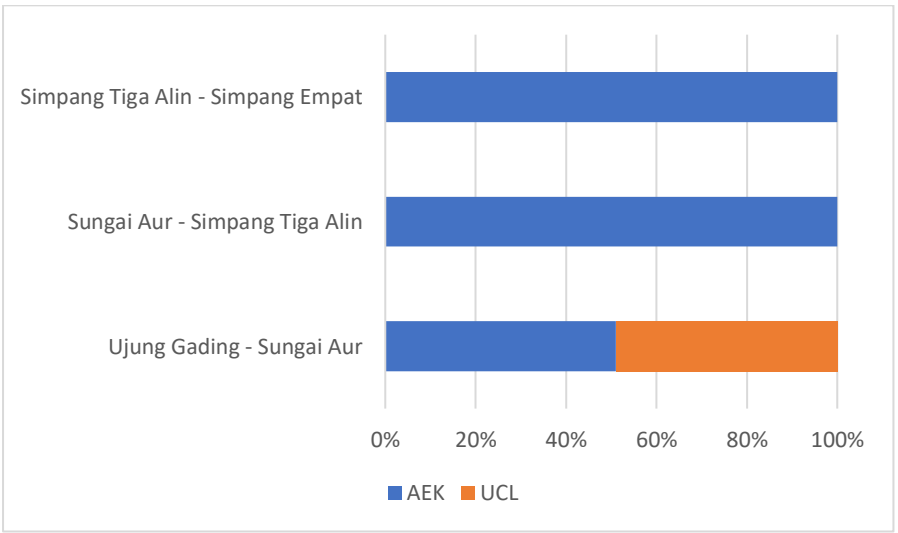

Figure 1. UCL Calculation Results 2018-2022

Based on Table 12. then the Ujung Gading-Sungai Aur, Sungai Aur - Simpang Empat, and Simpang Tigo Alin-Simpang Empat road sections are road sections that are stated as accident-prone points (Black Spots). For the highest number of accident-prone areas (black

spots) is the Ujung Gading-Sungai Aur road section. While of the three sections, the lowest number is on the Simoang Tiga Alin-Simpang Empat road section.

Solutions to Minimize the Number of Traffic Accidents That Occur

Based on the analysis of the main factors causing accidents, characteristics of accidents, determination of areas or points prone to accidents, and geometric data of the road. The solution can be obtained for handling actions taken to minimize the number of accidents, namely:

a. Law enforcement efforts (Enforcement)
b. Education (Education)
c. Engineering (Engineering)

Based on data analysis and observations during the study, the engineering aspects that need to be considered are as follows:

1. Repair/change of additional traffic signs/road markings carried out continuously according to needs
2. Determination of maximum and minimum speeds to prevent the use of roads in the wrong way
3. Continuous observation of black spots
4. Repair of horizontal and vertical alignments
5. Determination of pavement width and repair design
6. Street lighting
7. Superelevation repair
8. Road maintenance
9. Traffic flow design during construction

CONCLUSION

The main factor causing traffic accidents on the Ujung Gading-Simpang Empat Pasaman Barat Highway Section is the driver factor in the form of negligence in driving, disobeying established rules, unusual vehicle movements, not using rearview mirrors, poor distance estimation, not adjusting vehicle speed to surrounding conditions, etc. The driver factor is the biggest factor causing accidents with 330 cases in 2018-2022. In addition to the driver factor, the vehicle factor also influences traffic accidents with 75 cases in 2018-2022. The characteristics of traffic accidents on the Ujung Gading-Simpang Empat Pasaman Barat Highway Section from 2018-2022 are the type of vehicle, type of accident, location, and time of the accident. The highest accident-prone points (Black Spots) in 2018-2022 were Ujung Gading-Sungai Aur, followed by Sungai Aur - Simpang Tiga Alin and Simpang Tiga Alin - Simpang Empat. Handling solutions to minimize the number of accidents include law enforcement, education, and engineering efforts.

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