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AN ANALYSIS OF TRAFFIC ACCIDENT RATES IN DUMAI, RIAU PROVINCE

Abdul Kudus Zaini [1*], Sri Uswatun Hasanah Faza [2]
[1,2] Civil Engineering, Islamic Riau University, Jl. Kaharuddin Nst No. 113, Pekanbaru, Riau, Indonesia, Email: abdulkuduszaini@eng.uir.ac.id
*email Koresponden: abdulkuduszaini@eng.uir.ac.id

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Abstract
Roads, including land, sea, and air transport, are vital in the overall transportation system. However, a lack of focus on safety can lead to increased traffic accidents. This study analyzes accident data from five Dumai (Riau Province) roads with the highest accident rates. The analysis used secondary data, including traffic accident records and average daily traffic (ADT) from 2019 to 2023. The study followed a descriptive method with data collection through observation and documentation. The findings show that Soekarno Hatta Street experienced the highest number of accidents, totaling 107 incidents. The accident rate for the identified black spot on Soekarno Hatta Street in Bagan Besar Sub-District reached 0.727. Meanwhile, the black site on Cut Nyak Dien Street in Bangsal Aceh Village had an accident rate of 0.10.
Keywords: Road, Accident, Black Site, Black Spot.

1. INTRODUCTION

Roads are crucial in the transportation system, whether by land, sea, or air. A lack of attention to safety has contributed to increased traffic accidents. Transportation services are also closely tied to the safety of people and goods, and they play a key role in supporting development across all sectors in growing cities. Traffic accident victims may include fatalities, individuals with serious injuries, or those with minor injuries.

According to a report from the Dumai Regional Police, 367 traffic accidents occurred in Dumai between 2019 and 2023. Five roads recorded the highest incidents over the five years: Soekarno Hatta, Gatot Subroto, Arifin Ahmad, Cut Nyak Dien, and Raya Bukit Datuk Streets. These roads serve as arterial and collector routes. The data highlights the urgent need for targeted efforts to reduce traffic accidents on these roads.

Literature Review

Prasetyanto Dwi (2016) defines a traffic accident as an incident in which a motorized vehicle collides with an object, resulting in damage and, in some cases, injury or even death to humans or animals.

Meanwhile, Government Regulation No. 43 of 1993 concerning Road Infrastructure and Traffic (cited in Pujiastuti, 2006) defines a traffic accident as an unintentional and unexpected event that occurs on the road involving a vehicle with or without other road users, resulting in human casualties or property damage.

According to Setyowati *et al*. (2018), traffic accidents are the leading cause of death among adolescents aged 15 to 29. Low- and middle-income countries contribute to 90% of

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global road traffic deaths despite owning only about half of the world's vehicles. Cyclists, pedestrians, and motorcyclists represent the most vulnerable road users worldwide. If no effective measures are implemented, road traffic accidents are projected to become the seventh leading cause of death by 2030 (WHO, *Road Traffic Injuries*, 2015).

Highways, as key components of land transportation, play an essential role in regional development. They are constructed to facilitate the mobility of people and goods. In developing countries like Indonesia, highways contribute to economic progress and public health. However, increased highway use may also raise the risk of traffic accidents that result in injuries or fatalities.

As indicated by annual accident data, black spots refer to locations with a high concentration of traffic accidents. A road section qualifies as a black spot if its accident rate exceeds a defined threshold, determined using statistical probabilities (e.g., a value of 0.736). This classification highlights specific areas along the highway with an elevated risk of traffic incidents (Kudus, 1995).

Meanwhile, black sites are typically located on roads outside urban areas, particularly in segments with significantly higher accident frequencies. These sites are usually identified by distance—often more than 300 meters—from points with frequent accidents. The classification of a black site depends on the number of accidents per kilometer over 3–5 years. A location is considered a black site if the number of accidents exceeds two per kilometer during that time frame.

Additionally, a road section qualifies as a black site if its accident rate falls below a specific threshold—an accident rate of 0.003—indicating a high level of vulnerability (Kudus, 1995).

2. RESEARCH METHOD

This study uses a descriptive research approach, employing observation and documentation techniques to support data collection and analysis (Moh. Pabundu T., 2005). The study incorporates the following methods to gather the necessary data.

1. Field Observation
   This method involves systematically observing and recording signs or phenomena related to the research object. It is a direct data collection technique conducted in the field (Moh. Pabundu T., 2005: 44).
2. Documentation
   The documentation method collects data through visual records, such as photographs taken during field observations. These images are then analyzed to support the research findings (Moh. Pabundu T., 2005: 44).
3. Literature Review
   This method involves gathering and reviewing existing information and references relevant to the research problem. It supports the study's theoretical foundation and contextual understanding.

The tools and equipment used in this research include the following.

1. A measuring tape or meter to measure road width,
2. Stationery for note-taking and sketching,
3. A calculator for data processing,
4. A camera for field documentation, and
5. A computer, printer, and related equipment.

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The identification process consists of two stages. The first stage involves analyzing historical accident data across all study areas to identify locations with a high frequency of accidents (Indonesia's Emergency Transportation Education and Training Center, 1998).

A road section is classified as a black site if it meets specific criteria indicating accident vulnerability based on a threshold accident rate of 0.003 (Kudus, 1995). The formula for calculating black spots on highways is as follows.

$$R_{sp} = \frac{A \times 1{,}000{,}000}{365 \times V}$$

Where:
R_{sp} = Accident rate at the spot (accidents per vehicle per day)
A = Number of accidents during the observation period
V = Average daily traffic volume (vehicles/day)
365 = Number of days in a year

The following formula calculates black sites based on the accidents along a specific road segment.

$$R_{sc} = \frac{A \times 1{,}000{,}000}{V \times T \times 365}$$

Where:
R_{sc} = Black site rate
T = Length of the road section under study (in kilometers)
V = Average daily traffic volume
A = Average number of traffic accidents
365 = Number of days in a year

3. RESULTS AND DISCUSSION

Traffic accidents typically result from errors within the traffic system, which include drivers (humans), roads, vehicles, and environmental factors. These accidents cause injuries, fatalities, and/or property damage. A traffic accident is an unintentional and unexpected event that occurs on the road involving one or more vehicles, with or without the involvement of other road users. This analysis examines the number of traffic accidents on each road section, expressed in accident units per million kilometers traveled.

The accident rate analysis incorporates several variables, including official traffic accident reports from a specific period, weather and road conditions, accident types (e.g., head-on, side-impact, or rear-end), vehicle types, driver behavior, and other contributing factors. It also considers accident patterns, site characteristics, average daily traffic volume, and direct observations of traffic flow.

Table 1. Frequency of Traffic Accidents on the Five Roads with the Highest Incident Rates in Dumai

No.	Road Name	Years					Number of Accidents
		2019	2020	2021	2022	2023	
1	Soekarno Hatta Street	22	22	18	20	25	107
2	Gatot Subroto Street	6	3	7	8	12	36
3	Arifn Ahmad Street	7	6	8	7	10	38

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4	Cut Nyak Dien Street	1	1	5	6	9	22
5	Bukit Datuk Street	5	-	3	2	2	12
Total		41	32	41	43	58	215

Source: Dumai Regional Police, 2024

Based on the data provided by the Dumai Regional Police, Table 1 shows that out of 215 recorded incidents, Soekarno Hatta Street had the highest number of accidents, totaling 107 cases, followed by Arifin Ahmad Street with 38 cases. These two roads represent the most accident-prone locations in Dumai City.

Segment Division

Since the analysis involves multiple road sections, each road is divided into several segments based on the sub-districts with the highest traffic accidents. This segmentation helps identify black spots and sites more accurately along each road section.

Table 2. Frequency of Traffic Accidents in Sub-districts with the Highest Accident Rates per Road Section

No.	Road Segment (Sub-District)	Years					Number of Accidents
		2019	2020	2021	2022	2023	
1	Soekarno Hatta Street (Bagan Besar) KM 8.4–KM 13	13	12	6	12	8	51
2	Gatot Subroto Street (Mekar Sari) KM 6.2–KM 11.7	4	0	3	1	6	14
3	Arifin Ahmad Street (Teluk Makmur) KM 7.4–KM 12.5	3	2	1	3	3	12
4	Cut Nyak Dien Street (Bangsal Aceh) KM 6.7–KM 10	1	0	2	4	4	11
5	Raya Bukit Datuk Street (Bukit Datuk) KM 0.6–KM 6.6	3	0	3	2	2	10
Total		24	14	15	22	23	98

Source: Dumai Regional Police, 2024

According to Dumai Regional Police incident data shown in Table 2, the sub-districts with the highest number of traffic accidents on each analyzed road section are as follows: Bagan Besar Sub-District along Soekarno Hatta Street, Mekar Sari Sub-District along Gatot Subroto Street, Teluk Makmur Sub-District along Arifin Ahmad Street, Bangsal Aceh Sub-District along Cut Nyak Dien Street, and Bukit Datuk Sub-District along Bukit Datuk Street. Of 95 recorded accident cases, Bagan Besar Sub-District had the YStreet. This was followed by the Mekar Sari Sub-district, with 14 cases on the Gatot Subroto Street.

Identification of Black Spots and Black Sites

This study uses a statistical probability threshold of 0.736 to determine the baseline accident rate on the five road sections with the highest traffic accidents in Dumai. A location that approaches or exceeds this value is considered to be highly vulnerable to traffic accidents.

The parameters used to calculate the accident rate for identifying black spots are as follows.

1. The average annual accident frequency at the location (e.g., 51 accidents over 5 years = 10.2 accidents/year)

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2. Average daily traffic volume = 176,754 PCUs/day
3. The accident rate

$$R_{sp} = \frac{A \times 1{,}000{,}000}{365 \times V}$$
$$R_{sp} = \frac{10.2 \times 1{,}000{,}000}{365 \times 38{,}424.8}$$
$$R_{sp} = \frac{10{,}200{,}000}{14{,}025{,}052}$$
$$R_{sp} = 0.727$$

(Soekarno Hatta Street [Bagan Besar Sub-District])

Table 3. Results of Accident Rate Calculation for Black Spots on Road Sections Within Sub-Districts with the Highest Accident Frequencies

No.	Road Length (km)	Road Segment (Sub-District)	Total Accidents		Average Daily Traffic Volume	Accident Rate
			Total	Average per Year		
1	4.6	Soekarno Hatta Street (Bagan Besar) KM 8.4–13	51	10.2	38,424.8	0.727
2	5.5	Gatot Subroto Street (Mekar Sari) KM 6.2–11.7	14	2.8	19,761	0.38
3	5.1	Arifin Ahmad Street (Teluk Makmur) KM 7.4–12.5	12	2.4	24,656.5	0.27
4	3.3	Cut Nyak Dien Street (Bangsal Aceh) KM 6.7–10	11	2.2	17,643.3	0.34
5	6.5	Bukit Datuk Street (Bukit Datuk) KM 0.6–6.6	10	2	14,495.9	0.37

Source: Calculation Results (2024)

Table 3 shows that Soekarno Hatta Street in Bagan Besar Sub-District has the highest accident rate at 0.727, followed by Gatot Subroto Street in Mekar Sari Sub-District at 0.38. Both sections represent areas with a significant risk of traffic accidents. Soekarno Hatta Street in Bagan Besar Sub-District is categorized as a black spot, as its accident rate nearly meets the standard threshold of 0.736, indicating a high level of accident vulnerability at that specific location.

The analysis uses a standard accident rate threshold of 0.003 based on probability statistics to identify the most accident-prone road segments (black sites) among the five roads with the highest traffic accident rates in Dumai.

The following parameters are used to calculate the accident rate for black site identification.

1. The average number of traffic accidents
2. The length of the road section under study
3. The average daily traffic volume
4. The accident rate

$$R_{sc} = \frac{A \times 1{,}000{,}000}{V \times T \times 365}$$

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$$R_{sc} = \frac{10.2 \times 1{,}000{,}000}{38{,}424.8 \times 4.6 \times 365}$$
$$R_{sc} = \frac{10{,}200{,}000}{625{,}165{,}239.2}$$
$$R_{sc} = 0.016$$

(Soekarno Hatta Street [Bagan Besar Sub-District])

Table 4. Results of Accident Rate Calculation for Black Sites on Road Sections Within Sub-District with the Highest Accident Rates

No.	Road Segment (Sub-District)	Total Accidents		Average Daily Traffic Volume	Road Length (km)	Travel Performance	Accident Rate
		Total	Average per Year				
1	Soekarno Hatta Street (Bagan Besar) KM 8.4–13	51	10.2	38,424.8	4.6	176,754	0.016
2	Gatot Subroto Street (Mekar Sari) KM 6.2–11.7	14	2.8	19,761	5.5	108,686	0.07
3	Arifin Ahmad Street (Teluk Makmur) KM 7.4–12.5	12	2.4	24,656.5	5.1	125,748	0.05
4	Cut Nyak Dien Street (Bangsal Aceh) KM 6.7–10	11	2.2	17,643.3	3.3	58,223	0.10
5	Bukit Datuk Street (Bukit Datuk) KM 0.6–6.6	10	2	14,495.9	6.5	94,223	0.05

Source: Calculation Results (2024)

As shown in Table 4, the highest accident rate appears on Cut Nyak Dien Street in Bangsal Aceh Sub-District, with a value of 0.10. This result indicates that the road segment qualifies as a black site, as its accident rate far exceeds the statistical threshold of 0.003, confirming a high level of accident vulnerability.

Figures

The following charts and images illustrate the distribution and severity of traffic accidents across Dumai.

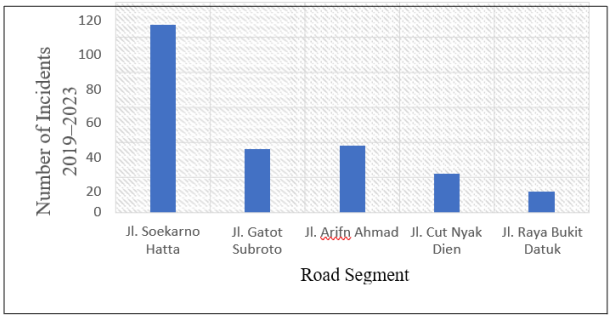

Figure 1. Bar Chart of Traffic Accident Frequency on the 5 Roads with the Most Incidents in Dumai

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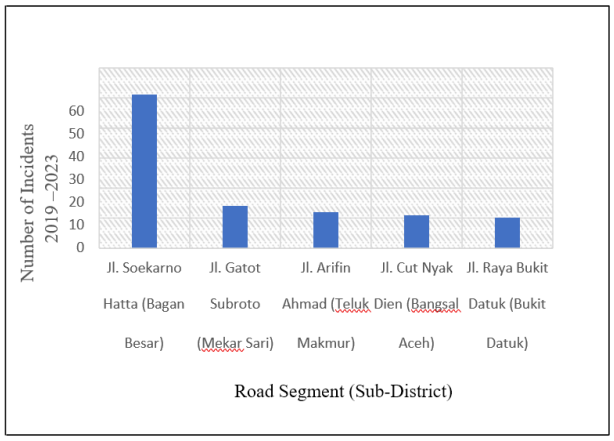

Figure 2. Bar Chart of Traffic Accident Frequency on the 5 Roads with the Most Incidents in Dumai

Figure 3. Road Condition of Soekarno Hatta Street

Figure 4. Road Condition of Gatot Subroto Street

Figure 5. Road Condition of Arifin Ahmad Street

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Figure 6. Road Condition of Cut Nyak Dien Street

Figure 7. Road Condition of Raya Bukit Datuk Street

4. CONCLUSION

Conclusions

This study analyzed traffic accident levels in Dumai, Riau Province, focusing on the five road sections with the highest accidents from 2019 to 2023. The findings show that Soekarno Hatta Street has the highest accident rate among the roads studied. It also qualifies as a black spot location. Meanwhile, Cut Nyak Dien Street recorded the highest black site value, with an accident rate of 0.10. The primary contributing factor to traffic accidents is human error.

To reduce traffic accidents, several prevention and mitigation efforts should be prioritized. These include technical improvements, such as repairing damaged or potholed roads, enhancing road safety infrastructure (e.g., road markings, zebra crossings, and traffic signs), and providing public education on traffic safety. In addition, strengthening the role of traffic police in regulating and enforcing traffic laws across Dumai City is essential.

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