

Identification of Accident-Prone Locations (Black Spots) Based on Accident Data Approach on La Ode Hadi – M. Brigjen Yoenoës Road, Kendari City

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ABSTRACT

Road safety remains a critical issue worldwide, particularly in low- and middle-income countries (LMICs), where the fatality rate from road accidents is significantly high. Excessive vehicle speed (over speeding) is one of the main contributing factors to the increasing frequency and severity of traffic accidents. This study aims to identify accident-prone locations (Black Spots) on La Ode Hadi – M. Brigjen Yoenoës Road, Kendari City using the Sliding Windows Method combined with the Accident Equivalent Rate (AEK) weighting system based on the Indonesian National Police guidelines. Secondary data were obtained from the Integrated Road Safety Management System (IRSMS) of the National Police, Kendari City Transportation Office, and supporting literature. The analysis shows that along the 4 km road section, there were 36 recorded accidents, dominated by motorcycle collisions (42%) with minor injuries (77%), front–rear collisions (42%), and mostly occurring at night (28%). The most accident-prone location identified was the Pasar Baru intersection as segment 11 (Sta 1+100) and 30 (Sta 3+000) with an AEK score of 37 points, exceeding the Black Spot threshold (>30 points). These findings confirm that the Pasar Baru intersection in Kendari City meets the criteria of a Black Spot area, emphasizing the need for targeted safety interventions such as improving the quality of the intersection, enhancing speed management, consistent law enforcement, and safety education campaigns to the public to reduce accident risks in urban Kendari.

Keywords: Road Safety; Black Spot; Accident Equivalent Rate (AEK); Sliding Windows Method, Kendary City..

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INTRODUCTION

Road safety is one of the major issues in transportation around the world. According to the region is recorded as the region with the highest death rate, especially among two- and Global Status Report on Road Safety, more than 1.19 million people died due to traffic accidents in 2021 and millions more were seriously injured. In addition, based on data reported by WHO, the Southeast Asia three-wheeled vehicle users who reach 48% of the total deaths. (World Health Organization, 2023).

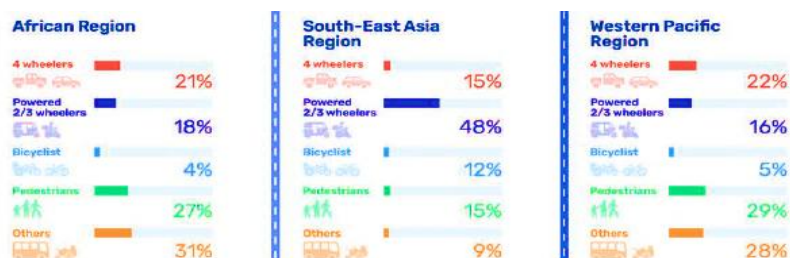


Figure 1 World Death Percentage by Road User Type
Source: WHO Global Status Report On Road Safety, 2023

High speeds significantly increase the risk of death from traffic accidents worldwide, especially in Low and Middle Income Countries (LMICs). In addition, based on a report issued by WHO in 2021, it shows that countries in (S. K. Fondzenyuy et al., 2024) the Low and Middle Income Countries region have the highest traffic fatality rates when compared to other regional regions.

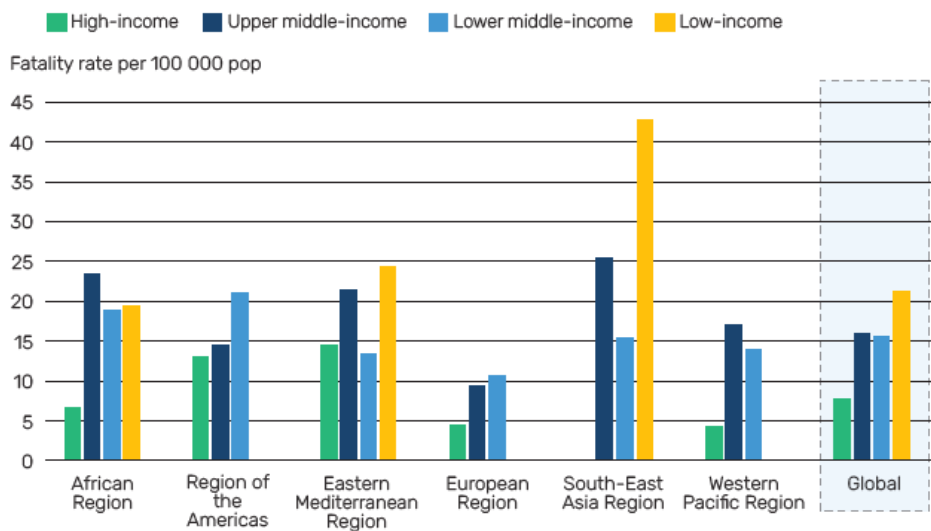


Figure 2 Traffic Fatality Rate by WHO Regional Region

Source: *WHO Global Status Report On Road Safety, 2023*

Excessive vehicle speed (Over Speeding) is one of the main risk factors in traffic accidents (Kumfer et al., 2023). Increased speed not only increases the risk of accidents (International Transport Forum, 2022), but also increases the severity of injuries (Aarts & Van Schagen, 2006) in accidents that occur. In particular, excessive and improper speed is associated with an increased risk of accidents, frequency, and severity of injuries (Mahmud & Raihan, 2024). Studies by (Nilsson, 2004) mention that every 1% increase in average speed results in a 4% increase in the risk of fatal accidents (Elvik et al., 2019) and a 3% increase in the risk of serious accidents. (European Commission, 2018). So it is important to reduce the speed of vehicles in areas densely populated by road users (e.g. on urban roads) dominated by pedestrians and cyclists (World Health Organization, 2023)

Road safety is a crucial issue especially in urban areas with high mobility. Kendari City, the capital of Southeast Sulawesi Province has a traffic accident rate that has been increasing year after year (Polresta Kendari, 2025) This can be seen in the graph below:

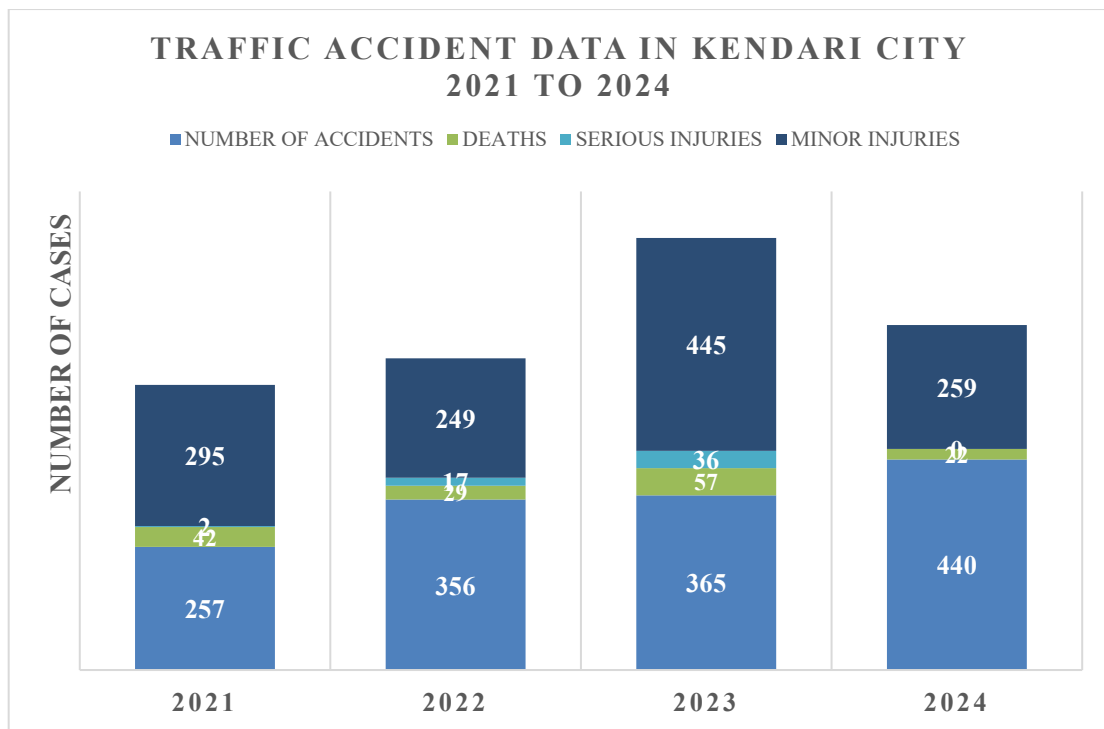


Figure 3 Traffic Accident Data in Kendari City 2021-2024

Source: Kendari City Police IRSMS, 2025

The high number of traffic accidents in Kendari City demonstrates the need for systematic efforts to identify and address potential accident-prone areas, characterized by a high number of high-risk accidents. One effective spatial analysis approach to detect accident-prone locations is the Sliding Windows method (Ghadi & Torok, 2017)(Tjahjono, 2019). This method can identify Black Spot locations through clustering patterns of accident types (Ghadi & Torok, 2019). By applying the Sliding Windows method, an accurate picture of the location of Black Spots that require major intervention to improve road safety can be obtained (Shabani et al., 2024). This phenomenon is particularly relevant in developing cities such as Kendari City with high traffic density and suboptimal road infrastructure. Based on this phenomenon, this study will examine how to apply the Sliding Windows method and the weighting of the Accident Equivalent Rate (AEK) of the National Police in identifying the location of Black Spots on La Ode Hadi-M. Brigadier General Yoenoes Road, Kendari City.

Based on this background, this study aims to identify accident-prone locations (black spots) on Jalan La Ode Hadi – M. Brigadier General Yoenoes Kendari City by using the Sliding Windows Method approach and the Accident Equivalent Rate (AEK) weighting system based on accident data. The goal is to accurately map accident-prone points, analyze their characteristics and causative factors, and provide appropriate technical and managerial recommendations to improve road safety. The benefits of this study are as a reference for local governments and authorities in planning effective safety interventions, such as road geometry improvements, law enforcement, and driving awareness campaigns, so as to reduce the number of accidents and reduce the socio-economic impact they cause in the urban area of Kendari.

METHOD

This research was conducted in Kendari City, Southeast Sulawesi Province on the La Ode Hadi – M. Brigadier General Yoenoes road along 4 km for each directions. The time used by the researcher for this research is carried out from the date of issuance of the research permit within a period of approximately 5 (five) months, starting from April to August 2025.

Secondary data is obtained by the researcher by requesting data to agencies that have authority in the data needed by the author. Secondary data can also be obtained by the author through literature studies from books, as well as previous research, through the internet, reference books and books in the library. The secondary data used in this study are:

1. Traffic accident data (number of accidents, type of accident, main cause of accident, number of victims, time of incident, location of incident equipped with location coordinate points) from the Southeast Sulawesi Regional Police and the Kendari City Police sourced from the IRSMS of the National Police;
2. Data on the location suspected of being Black Spots in Kendari City from the IRSMS of the Kendari Police;
3. Road Network Map/status and city road section numbers in Kendari City from Kendari City Transportation Office;
4. Policies and regulations related to speed limits used by the Kendari City Transportation Office.

The identification of this problem aims to test the location of the Accident Prone on the La Ode Hadi - M. Brigadier General Yoenoes road of Kendari City. The determination of the Black Spot was carried out using the weighting method in Indonesia, which is based on the fatality rate of accident victims weighted by the AEK (Accident Equivalent Number) (Novriani, 2021) of the National Police weighting guidelines (Polri, 2016)

Table 1. Weighting of Accident Victims Police Guidelines

Accident Class	Information	Weight
Passed Away (MD)	Fatal Accident	10
Serious Injuries (LB)	Accidents with Serious Injuries	5
Minor Injuries (LR)	Accidents with minor injuries	1

Source: Korlantas Polri (Polri, 2016)

Furthermore, based on the Black Spot location data issued by the Kendari Police sourced from the IRSMS database of the National Police, it is known that there are 4 locations that are suspected of Black Spots. Based on this data, the researcher tested that the location was correct for the location of the Black Spot based on the weighting of injuries exceeding 30 points per segment along 300-500 meters using pin analysis on the Google Earth Pro. 10.8 application. In addition, analysis was carried out using the Sliding Windows method (Novriani, 2021) to ensure that the IRSMS Black spot data was accurate according to the coordinate point of the accident site. The main goal of (Shabani et al., 2024) the Sliding Windows method is to identify the exact start and end points of the Black Spot location along a road section that contains homogeneous traffic and similar environmental attributes. Furthermore, the location (Ghadi & Torok, 2017) of the Black Spot was obtained based on the weighting method of the Accident Equivalent Number.

RESULTS AND DISCUSSION

Analysis of Accident-Prone Locations (Black Spots)

In this chapter, the analysis carried out is the identification of accident-prone locations (Black Spots) around the intersection area of Pasar Baru Kendari City. Black Spot location testing is carried out using the Sliding Windows method approach, which is an analysis technique by identifying the location based on the shift of the window to the location coordinate point.

Characteristics of La Ode Hadi–M. Brigadier General Yoenoes Road Section

This research was conducted in Kendari City, Southeast Sulawesi Province which stretches as far as 4 Km, namely 2 Km on the La Ode Hadi Road section from the direction (South to North) and 2 Km on the M. Brigadier General Yoenoes road section from the direction (North to South) with 2 directions. In general, this road is a city road with a function as a secondary arterial road that connects Kendari City with strategic areas such as airports, markets, shopping centers and other strategic areas. The type of road at the study site is 4/2 D (Divided), which is separated by a central median that can minimize vehicles from the opposite direction to pass directly.



Figure 4. Inventory of existing roads La ode hadi-M. Brigadier General Yoenoes

Source: Data processed by the Author, 2025

Characteristics Based on the Severity of the Accident

Along the 4 Km research area, there were 36 cases of accidents that occurred, most of which were minor accidents but there were also accidents with serious injuries and fatalities which can be seen based on the graph below:

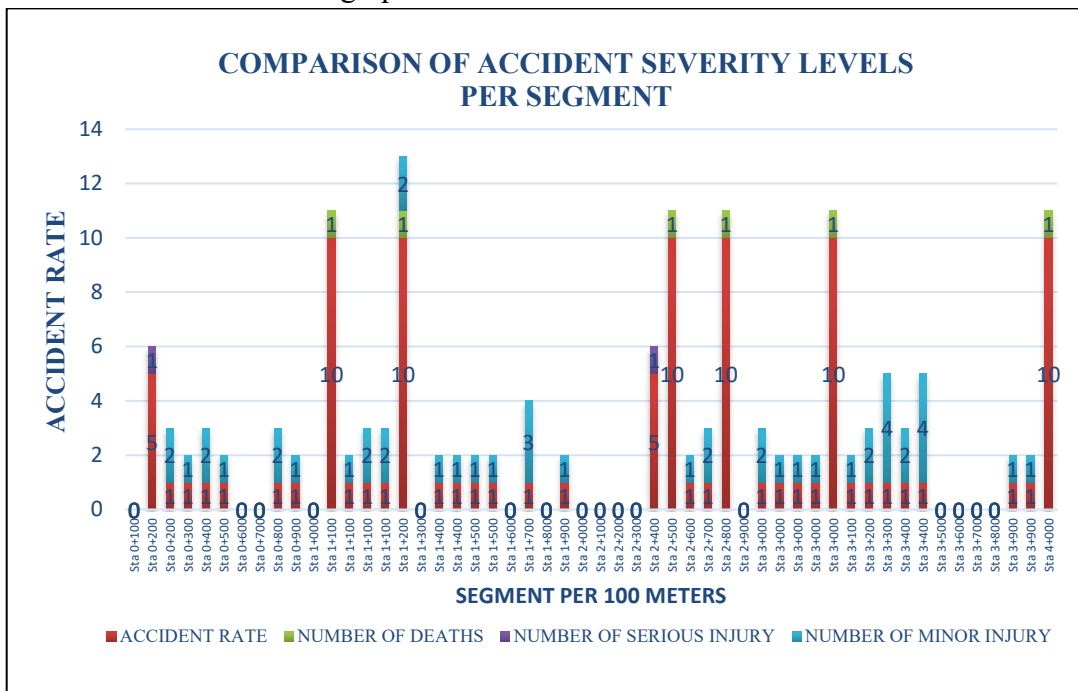


Figure 5. Severity of Accidents Per Segment
 Source: Data IRSMS processed by the Author, 2025

Based on the graph above, of the 40 segments in this study, 24 segments had accident cases and there were only 16 segments that did not have accidents. Most of the accidents are classified as minor with the Police Weighting Accident Equivalent Number, namely (Light Injuries/LR= 1 point) of 28 cases or around 77%. Accidents that caused victims (Died/MD=10 points) were 6 cases or about 17% and accidents that caused (Serious Injuries/LB= 5 points) there were 2 cases of around 6%. The results indicate that most accidents were classified as minor. However, the presence of fatal and serious injury cases highlights the critical need for effective speed management and safer road design interventions. This finding aligns with (Jurewicz et al., 2016) who emphasized that vehicle impact speed strongly correlates with injury severity, and road design should be adapted to human tolerance levels to minimize crash consequences.

Characteristics by Type of Accident

Identification of accident types is very important (Ghosh & Karmakar, 2025) to understand the risk patterns of accident types that most often occur on the La Ode Hadi - M. Brigadier General Yoenoës road. By understanding these causes and types of accidents, evaluation can be carried out and it is easier to determine the right safety intervention to minimize the risks of accident (Elvik, 2024). An image visualization of the accident type can be seen in the image below:

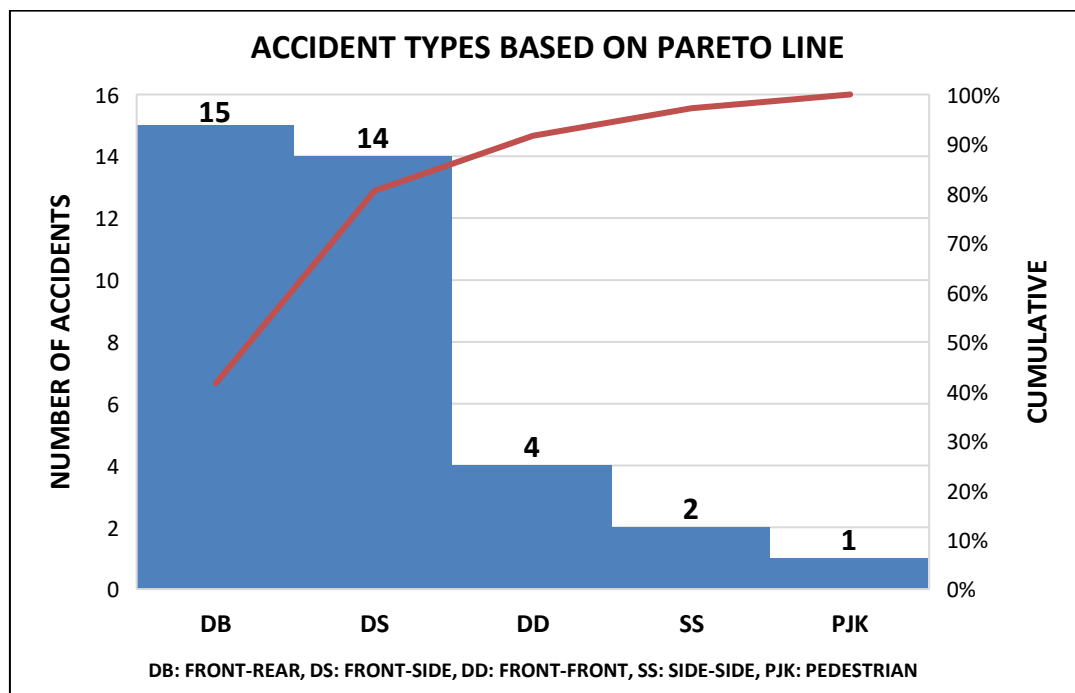


Figure 6. Severity of Accident

Source: Data IRSMS processed by author, 2025

The graph above shows that of the total 36 accidents recorded, most of them were DB (Front-Rear) collision accident type with 15 cases or around 42%. The type of DS (Front-Side) collision occurred in 14 cases which is equivalent to 39%. DD (Front-Front) collision occurred in 4 cases which were equivalent to 11%, SS (Side-Side) collision occurred in 2 accident cases which were equivalent to 6%. In addition, there was 1 accident involving pedestrians which was equivalent to 3%. The analysis revealed that front–rear and front–side collisions were the most dominant crash types in urban areas (Theofilatos et al., 2012), accounting for more than 80% of all recorded accidents. This suggests that inadequate headway distance, excessive speed, and suboptimal geometric road design are major contributing factors. These findings are consistent with studies by (Elvik et al., 2019) which emphasize that higher vehicle speeds and insufficient sight distances increase the likelihood and severity of vehicle-to-vehicle crashes specifically at intersections (Lee & Abdel-Aty, 2005).

Types of Vehicles Involved

The types of vehicles involved in accidents at the research site are quite diverse. This can be seen in the graph below:

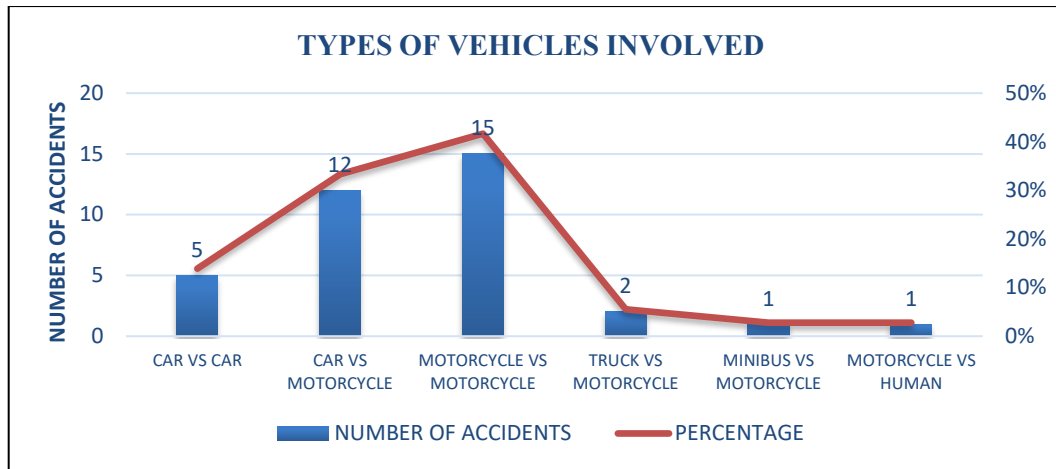


Figure 7. Types of Vehicles Involved

Source: Data IRSMS processed by author, 2025

From the graph above, it can be concluded that the majority of the types of vehicles involved in accidents are dominated by Motorcycle Vs Motorcycle vehicles which occurred in 15 cases or equivalent to 42%. Then followed by the type of Car Vs Motorcycle vehicle, which is 12 cases or equivalent to 33%. Car Vs Car vehicle types there are 5 cases which are equivalent to 14%. There are also types of vehicles involved in accidents between Trucks Vs Motorcycles, which are 2 cases or equivalent to 5%. In addition, there is a type of Minibus Vs Motorcycle vehicle with 1 case which is equivalent to 3% and Motorcycle Vs Human, namely a motorcycle collision with a pedestrian, there is 1 case or equivalent to 3%. The findings indicate that motorcycles were the most frequently involved vehicle type in crashes, particularly motorcycle-to-motorcycle and motorcycle-to-car collisions. This suggests a high vulnerability of motorcyclists due to their physical exposure (Das et al., 2023) and risky behavior at higher operating speeds. Therefore, mitigation strategies are needed to reduce the severity of collisions between cars and two-wheelers particularly through driver behavior control, improved road visibility conditions, and traffic management based on time and weather (Liu et al., 2022).

Characteristics Based on Time of Occurrence

If referring to the time of the accident, it can be seen in the graph below:

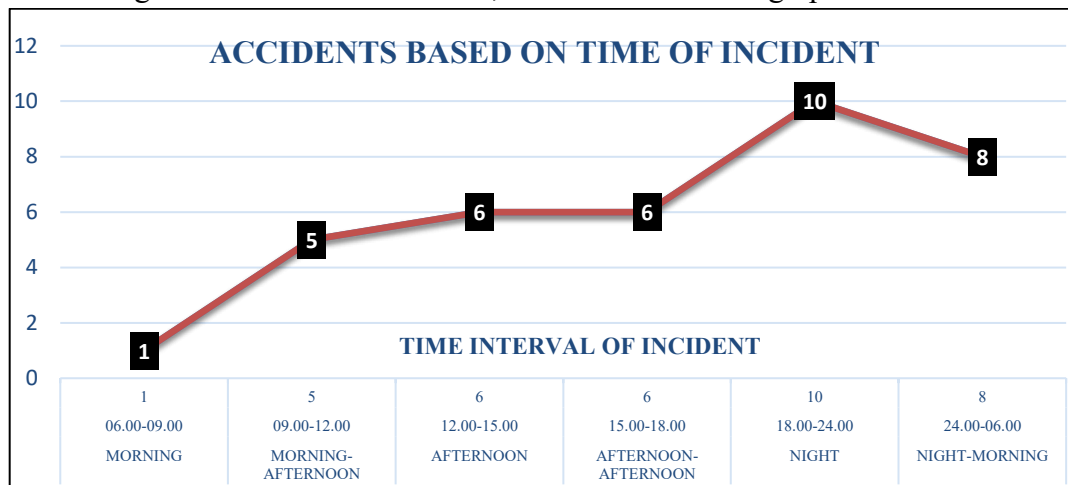


Figure 8. Accidents by Time of Occurrence

Source: Data IRSMS processed by author, 2025

From the graph above, it can be concluded that the accident on the La Ode Hadi-M road. Brigadier General Yoenoes occurred the most at night, which was in the range of 18.00-24.00 WITA, which was as many as 10 cases which was equivalent to 28%. Between 24.00-06.00 WITA (night to morning) there were 8 accident cases equivalent to 22%. Accidents during the day towards the afternoon range of 12.00-18.00 WITA there were 12 cases of accidents or equivalent to 34%. In the morning time range at 09.00-12.00 WITA there were 5 cases equivalent to 14% and there was 1 case equivalent to 2% that occurred in the time range of 06.00-09.00 WITA, namely during the morning peak hour. The analysis indicates that most crashes on La Ode Hadi – M. Brigadier General Yoenoes road occurred during the evening and night time periods (18:00-24:00 and 24:00-06:00), suggesting that reduced visibility, driver fatigue, and higher post-work traffic activity significantly contribute to crash risk. This finding emphasize that night time conditions (Theofilatos et al., 2012) and limited visibility substantially increase both the likelihood and severity of road crashes.

Material Loss Due to Accident on La Ode Hadi-M. Brigadier General Yoenoes Road

Traffic accidents not only cause casualties and injuries but also have a significant impact on material losses. Based on the data obtained, it was found that there were material losses due to accidents in 36 cases in this research segment which can be seen in the graph below:

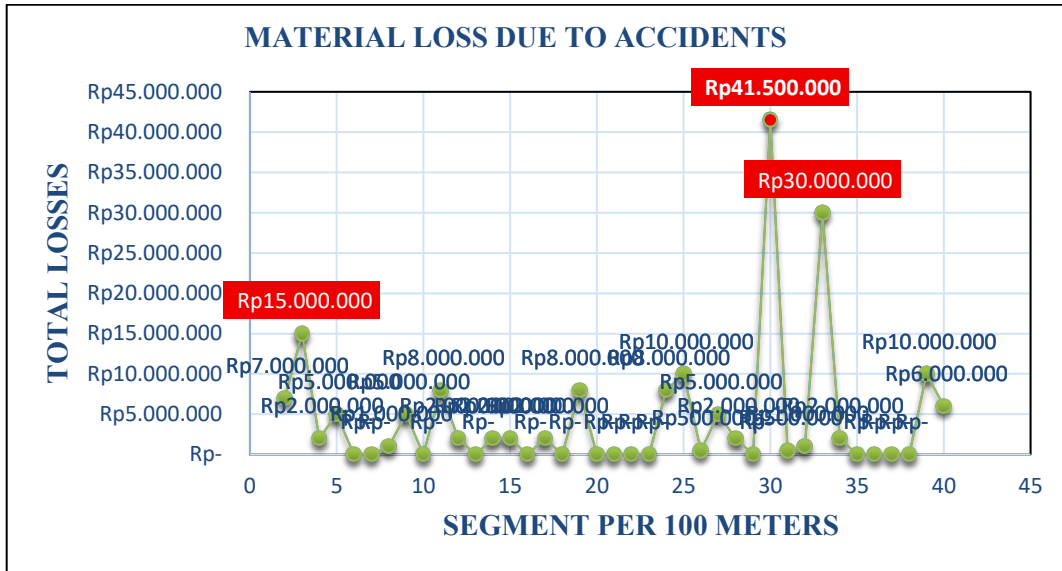


Figure 9. Rate of Material Loss Due to Accident
 Source: Data IRSMS processed by author, 2025

Based on the image above, it can be seen that the material losses incurred are quite significant. The highest material loss was in segment 30 which is the intersection location (*Black Spot*) which reached Rp.41,500,000 for 5 accident cases, segment 33 reached Rp.30,000,000 for 1 accident case. The most dominant damage comes from vehicles that experience collisions, both light and heavy, which has an impact on the cost of repairing private vehicles and public transportation. In addition, this loss also includes damage to road infrastructure such as signs, traffic lights, as well as the cost of vehicle evacuation and handling of victims after the accident. The magnitude of these losses shows that traffic accidents not only have an impact on the aspect of life safety (Mohammed et al., 2019), but also provide a considerable economic burden for both individuals and local governments (Blincoe et al., 2015).

Identify Accident-Prone Locations (Black Spots)

The location that is suspected to be the location of the Black Spot based on data from the Integrated Road Safety Management System (IRSMS) of the National Police is an area at the Pasar Baru intersection. So that in this study, a test of the location of the Black Spot will be carried out using the weighting of the AEK Polri using the Sliding Windows method on Google Maps with the following conditions:

1. The limit of the road section is the length of the study 0-500 meters. If at the intersection, the distance is 100-200 meters from the mouth of the intersection;
2. The time limit is accident data for the last 2 to 3 years;
3. The value that presents the condition of the severity of the accident (Severity) is a weighting

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value of at least >30:

- Serious accidents with the severity of the deceased received a weight of 10;
- Serious accidents with the severity of the victim with serious injuries gained a weight of 5;
- Minor accidents with the severity of the victim with minor injuries gained a weight of 1.



Figure 10. Existing Location of the New Market Intersection (Black Spot)
Source: *Dj Air 3S Drone*, 2025

The picture above is a location that is suspected to be a *Black Spot* because it has a high rate of traffic accidents based on accident data from the Kendari Police. This location is at the intersection point which is a city road that connects the La Ode Hadi road section with the M. Brigjen Yoenoës road section. The testing of the *Black Spot* location using the Sliding Windows method can be seen in the image below:

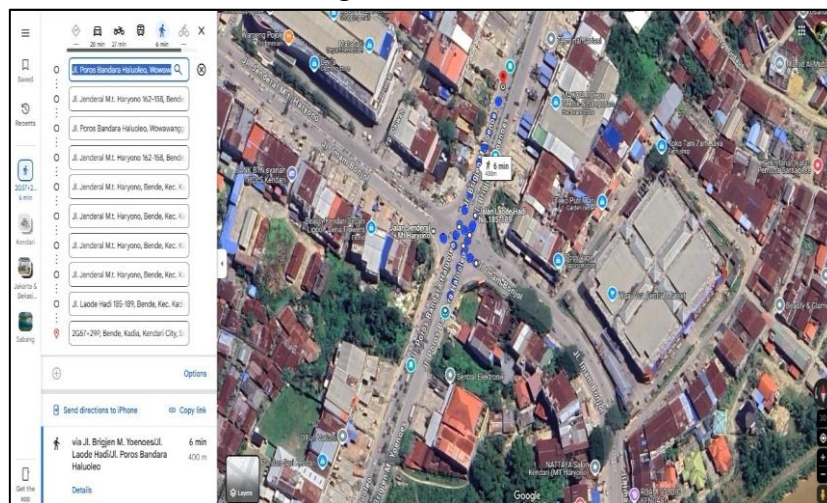


Figure 11. Use of the Windows Sliding Method at Intersections
Source: *Google Maps*, 2025

Based on the results of the window shift test using *Google Maps* on the coordinate points of 10 accident cases at the Pasar Baru intersection, it is known that the overall length of the study segment reaches 400 meters and is less than 200 meters from the mouth of the intersection. These findings show that the location meets the criteria as an Accident-Prone Location based on the length limit of the study in the National Police guidelines. With these criteria met, the next step needed is to weighting the severity of the accident to gain a deeper understanding of the level of accident risk at this location. The calculation of the weight of the accident is presented in the table below:

Table 2. Calculation of Accident Weight at Pasar Baru Intersection

No.	Date of Occurrence	Number of Victims			Weight
		MD	LB	LR	
1	2022-12-08	-	-	1	1
2	2022-12-13	-	-	1	1
3	2022-12-15	-	-	2	1
4	2023-01-27	1	1	-	10
5	2023-06-28	-	-	1	1
6	2023-08-07	1	-	-	10
7	2024-02-05	-	-	2	1
8	2024-06-30	-	-	2	1
9	2024-09-24	1	-	2	10
10	2024-12-17	-	-	1	1
Total		3	1	12	37

Source: IRSMS Accident Data, 2025

Based on the table above, it can be concluded that the severity of the accident at this intersection location meets the Black Spot criteria with the acquisition of an Accident Equivalent Score (AEK) of 37 points, which exceeds the threshold of 30 points > in the Guidelines for the Determination and Assessment of Black Spots by the Indonesian National Police. After the AEK weighting is carried out, the next stage is the preparation of an accident diagram/Collision Diagram and collision matrix to describe the patterns and characteristics of accidents that occur at that location and we can see this in the image below:

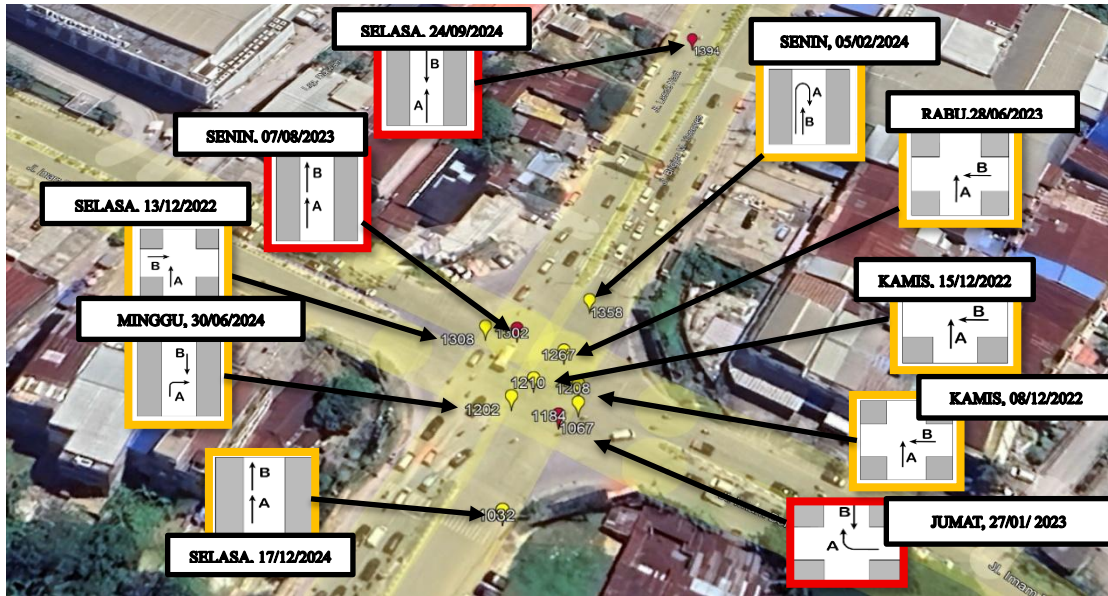


Figure 12. Collision Diagram At Pasar Baru Intersection in Kendari

Source: Data processed by author, 2025

The collision diagram provides a visual representation of the crash patterns and vehicle movements at the intersection, illustrating the exact locations, directions, and types of impacts that occurred.

Tabel 3. Collision Matrix Table at Pasar Baru Intersection

Accident Serial Number	1208	1308	1210	1067	1267	1302	1358	1202	1394	1032
Accident Code	1	2	3	4	5	6	7	8	9	10
Date of Occurrence	2022-12-08	2022-12-13	2022-12-15	2023-01-27	2023-06-28	2023-08-07	2024-02-05	2024-06-30	2024-09-24	2024-12-17
Vehicles Involved	Minibus vs Sedan	Motorcycle vs Motorcycle	Sedan vs Motorcycle	Motorcycle vs Motorcycle	Sedan Vs Sedan	Sedan vs Motorcycle	Small Truk Vs Motorcycle	Motorcycle vs Motorcycle	Motorcycle vs Motorcycle	Motorcycle vs Motorcycle
Geometrik Form	Signalized Four-Leg Intersection	Signalized Four-Leg Intersection	Signalized Four-Leg Intersection	Signalized Four-Leg Intersection	Signalized Four-Leg Intersection	Signalized Four-Leg Intersection	Signalized Four-Leg Intersection	Signalized Four-Leg Intersection	Straight Section	Straight Section
Time of Occurrence	16.20 WITA	10.30 WITA	01.30 WITA	20.30 WITA	02.00 WITA	09.15 WITA	23.30 WITA	00.15 WITA	17.30 WITA	14.25 WITA
Lighting Condition	Bright/Clear	Bright/Clear	Dim / Poor Visibility	Dim / Poor Visibility	Dim / Poor Visibility	Bright/Clear	Dim / Poor Visibility	Dim / Poor Visibility	Bright/Clear	Bright/Clear
Type Of Collision	Front-Side	Front-Side	Front-Side	Front-Side	Front-Side	Rear-End	Front-Side	Front-Side	Head On	Rear-End
Weather	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

Diagram Collision	Severity
	Minor
	Minor
	Minor
	Fatal
	Minor
	Fatal
	Minor
	Minor
	Fatal
	Minor

Source: Data IRSMS processed by author, 2025

The collision matrix systematically summarizes the same data in a structured format, allowing for easier identification of recurring accident types, involved vehicle categories, and contributing factors. Together, these two analytical tools offer a comprehensive understanding of the accident characteristics at the black spot location.

CONCLUSION

Based on the collision diagram and matrix, the Pasar Baru intersection (segments 11 and 30) meets the 2016 Indonesian National Police criteria for an Accident-Prone Location (Black Spot). To improve safety, recommendations include minimizing turning movements through canalization or traffic island markings, channeling forward movements with enhanced road markings, and reducing pedestrian conflicts by providing zebra crossings and pedestrian-only signs. Further measures involve improving visibility by clearing roadside obstructions, managing speed through road geometry engineering, enhancing night-time safety with better lighting and reflective signage, and enforcing stricter traffic regulations including E-TLE camera installations at high-violation spots. Additionally, public awareness should be raised through safety education campaigns. Future research could focus on evaluating the effectiveness of these interventions over time and exploring the integration of smart traffic management technologies to further reduce accident risks at Black Spots.

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