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Improving Traffic Safety for KM 212 on the Palembang-Jambi Cross Road, Musi Banyuasin Regency

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Abstract. The Palembang-Jambi Cross road is located in the Musi Banyuasin Regency. The road section has a primary arterial function with a design speed of 60 km/hour. The Palembang-Jambi Cross road is a Sumatran highway that connects islands between provinces in Sumatra and Java. With such conditions, traffic problems arise in the form of traffic accidents. Therefore, to overcome these traffic problems, an analysis is needed to overcome these problems.
The analytical method used in this research is macro analysis and micro analysis. Macro analysis was carried out to determine the general characteristics of accidents, how the tendency of traffic accidents to occur on the Palembang-Jambi KM 212 road section. Macro analysis used simple numerical analysis, namely analysis of the time of the accident, analysis based on the month of occurrence, analysis of accident victims, analysis of type of accident. Micro analysis consists of several analyzes consisting of analysis based on accident chronology data, analysis of factors causing accidents, analysis of instantaneous speed and analysis of stopping visibility. After doing this analysis, it can be concluded that the factors that cause accidents that often occur at KM 212 Jalan Lintas Palembang – Jambi are infrastructure factors and human factors. The infrastructure factor is the main factor in the accidents that occur. So that this research is needed in order to overcome these problems such as additions, replacements and maintenance for road equipment facilities in accordance with technical requirements.
With this handling, it is hoped that it will be able to reduce the impact of the causes of traffic accidents and reduce the number of KM 212 traffic accidents on the Palembang-Jambi Cross Road, Musi Banyuasin Regency.

1. Introduction

Based on law number 22 of 2009 article 1 numbers 31 and 24, traffic safety and road transportation is a state of avoiding everyone from the risk of accidents during traffic caused by humans, vehicles, roads, and/or the environment. Meanwhile, a traffic accident is an event on the road and does not involve a vehicle with or without other users, resulting in human casualties and/or property loss.
Musi Banyuasin Regency is one of the regencies in South Sumatra Province. The highest traffic volume is on the Palembang-Jambi Cross Road with type 2/2 UD, the length of the road is 127 Km, the status of the National road with the average vehicle speed is quite high > 50 Km/hour. This road section is a Trans Sumatra that connects between provinces in Sumatra.
Harmoko Bend is the highest accident-prone area of the accident rate and fatality rate, which is located at KM 212 Palembang-Jambi Cross Road, Musi Banyuasin Regency. There were 9 accidents in 2019 with 6 deaths, 8 serious injuries and 1 minor injury. There are various characteristics of accidents and types of collisions and there is still a lack of road equipment facilities that can endanger the safety of road users. The purpose of this study is to determine the characteristics of the accident and identify the factors causing the accident, so that it can be proposed to reduce the number of traffic accidents with a high fatality rate.

2. Literature review

2.1. Traffic Accident

Based on the analysis of accidents, road safety and education (ALLAJR Training Center 1998) clarifies the factors that cause accidents, namely:

a. Human (Driver)
   The criteria for drivers who cause accidents are fatigue, boredom, age, the influence of alcohol, drugs and the like.
b. Vehicle
   The cause of the accident is due to technical conditions that are not roadworthy or their use is not in accordance with the provisions such as failed brakes, broken tires, sudden engine failure and others.
c. Road
   Factors causing accidents if there is damage to the road surface such as potholes, or imperfect road geometry such as the degree of slope is too small or too large at a turn, the driver's view is not free.
d. Environment
   Factors that cause accidents are fog, thick smoke or rain so that the driver's vision is greatly reduced to be able to drive the vehicle safely.

2.2. handling of accident-prone locations

According to the guidelines for handling traffic accident-prone locations (2004), traffic accident-prone locations are locations where traffic accidents often occur with certain benchmarks, namely there is a starting point and an end point which includes sections (accident-prone lanes) or nodes (intersections). each of which has a certain length. Road sections within the city are determined to be a maximum of 1 (one) Km and outside the city are determined to be a maximum of 3 (three) Km.

2.3. Safe Road Concept

According to Djoko Muryanto, 2012, Technical Guide 1 Road Safety Engineering, Ministry of Public Works of the Republic of Indonesia, and Mulyono, 2013, explains the criteria for safe roads as a consequence of the enactment of Law of the Republic of Indonesia Number 22 of 2009. A safe road is a road that is designed and operated in such a way that the road can inform, warn and guide drivers through an unusual section or segment of the road. To realize this path, there are three aspects that must be met, including:

a. Self Explaining Road
   The road must be able to informatively explain to the user the times when the user hesitates to cross the road.
b. Forgiving Road
   The road must be able to protect the user's life when the user is careless or negligent and violates the rules when crossing the road.
c. Self Regulating Road
   Roads must be able to meet technical standards so that there is no safety deficiency for users.

3. Research methodology

3.1.Data collection

The data used are secondary data and primary data. Secondary data was obtained from the Satlantas Police Resort, Musi Banyuasin Regency. While primary data is collected through traffic surveys, such as an inventory survey of accident-prone locations, instantaneous speed surveys, classified traffic volume surveys, and interview surveys of accident-prone locations. The data collected includes: traffic accident data, inventory data, instantaneous speed data, traffic volume data and interview results of accident-prone locations.

3.2.Method of analysis

The analysis method uses macro analysis and micro analysis. Macro analysis is used to identify the priority of problem handling based on its fatality, while micro analysis is a detailed analysis with the aim of increasing safety with 4 factors, namely humans, vehicles, roads and the environment.

4. Result and discussion

4.1. Macro Analysis

This analysis was conducted to find out how the tendency for traffic accidents to occur in Musi Banyuasin Regency. Macro analysis is used to identify general accident characteristics such as analysis of the time of occurrence, analysis of accident victims and analysis of types of accidents carried out in the following stages:

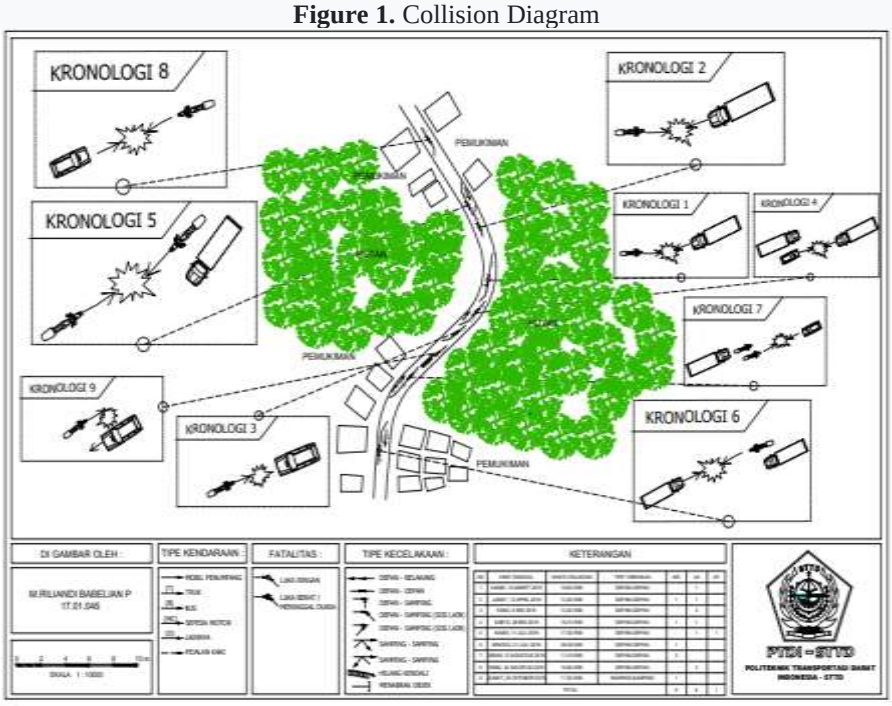
Table 1. Accidents Per Year

No	Year	Number of Accidents	Severity of Victimsw		
			MD	LB	LR
1	2015	6	4	7	3
2	2016	6	2	1	6
3	2017	8	5	6	2
4	2018	6	3	5	5
5	2019	9	6	8	1
TOTAL		35	20	27	17

From the table above, it can be concluded that the traffic accidents that occurred were not light accidents, seen from the number of accident victims who died every year for the last five years. As well as the lack of road equipment facilities in 2019 at the Harmoko Bend which can trigger accidents with high casualty fatalities.

4.2. Micro Analysis

Figure 1. Collision Diagram



The collision diagram above explains the type of collision that occurred at the Harkoko KM 212 bend on the Palembang-Jambi Cross Road.

a. Analysis of the Causes of Accidents

1. Road Factor

Table 2. Comparison of road geometric factors

No	Description	Standard		Reality		Deviation
		Size (m)	Function	Size (m)	Function	
1	Lane Width	2.75 – 3.05	The part of the lane that extends with or without road markings, which has a width sufficient for one motor vehicle to run, other than a motorcycle.	3.5	Many vehicles are found that overtake exceeding the lane limit used.	The lane is not used according to its function.
2	Road Shoulder Width	2.5	The side of the road is used for vehicles that are damaged and must make an emergency stop.	2.5	There is a height difference between the shoulder of the road and the traffic lane	there is a difference in height between the shoulder of the road and the traffic lane

From the table above, it can be concluded that the geometric condition of the road on the harmoko bend has met the standard, but there is still a difference in height between the shoulder of the road and the traffic lane and the absence of a median on the harmoko bend which can cause accidents with front-front type accidents

Table 3. Comparison of road completeness factors

No	Description	True Function	Existing Condition	Deviation
1	Road Markings	To direct traffic and limit areas of interest to traffic	There are no road markings yet	There are no road markings that can endanger the safety of motorists
2	Sign	To give orders, instructions, prohibitions, or warnings to road users	There are some signs that have been damaged	the addition of signs in accident-prone locations is very important to reduce the number of traffic accidents, especially warning signs
3	Street Lighting	As a navigation aid for road users, improving the safety and comfort of road users, especially at night and providing a beautiful environment	Lack of Street Lights	The addition of street lighting is very important to improve driver safety at night

From the table above, it can be concluded that there are no road markings that can endanger the driver, there are signs in a damaged condition and there are no warning signs, and the lack of street lighting at the Harkoko bend.

2. Vehicle Factor

Table 4. Comparison of vehicle factors

No	Vehicle Worthiness Factor	Standard	Reality	Deviation
1	Brake Condition	Worthy	Worthy	Brakes in good condition
2	Steering Condition	Worthy	Worthy	Steering is in good condition

3	Tire Condition	Worthy	not feasible	There was one accident caused by a non-standard tire condition
4	Front Axle Condition	Worthy	Worthy	Front axle is in good condition
5	Rear Axle Condition	Worthy	Worthy	Rear axle is in good condition
6	Headlight Condition	Worthy	Worthy	Headlights in good condition
7	Taillight Condition	Worthy	Worthy	Taillight in good condition
8	Chassis Condition	Worthy	Worthy	The chassis is in good condition

The vehicle factor greatly influences the incidence of accidents, because before traveling/movement a person using a motorized vehicle such as a motorcycle, car, bus and others must first check the condition of the vehicle before use. One of the causes of traffic accidents based on the vehicle factor at KM 212 Harmoko Bend Spot on the Palembang-Jambi Cross Road, Musi Banyuasin Regency, is the improper condition of the tires. This is because there are accidents that start from improper tire conditions, vehicles with high speeds around corners, making the driver lose control and can cause traffic accidents.

3. Human Factor

Table 5. Description of traffic ethics

No	Description of Traffic Ethics	Standard
I. **Driver**		
1	Age	≥ 17 Years
2	SIM	Own
3	Helmet/Safety Belt	Use
4	Concentration: a. off guard b. Sleepy c. Tired d. Mental Stress e. Effect of Alcoho	a. Don't be careless b. Not sleepy c. Not tired d. Not Under Mental Pressure e. Not Under the Effect of Alcohol
5	Traffic Rules Obedience a. Speed Sign b. Marks Can't Precede c. Be Careful Sign	a. Obey b. Obey c. Obey
II. **Passenger**		
1	Helmet/Safety Belt	Use

The table above is a table of indicators/descriptions of traffic ethics. From the chronology of accidents in 2019 it can be concluded that there are still motorists who are under 17 years old and do not have a driver's license, lack of knowledge of the importance of traffic safety so that there are still motorists who do not use helmets/safety belts. This can result in accidents with a high fatality rate. As well as the lack of road equipment facilities at the Harkoko bend which can endanger motorists due to the absence of traffic rules.

4. Environmental Facktor

Table 6. Safety Indicators Based on Environmental Factors

No	Environmental factor	Standar
1	Street Vendors Do	Not Disturb
2	Land Use Does	Not Disturb
3	Foggy	Not Foggy
4	Rain	Not Rain
5	Natural Disasters Occur	No Natural Disasters
6	Forest Fires Occur	No Forest Fires
7	There are fallen trees	There are no fallen trees

Environmental factors only slightly affect the traffic accidents that occur, from several chronology of accidents there is only one factor that affects the rain. Because there was one accident that occurred when it was raining. This can interfere with the driver's view while driving so that it can cause traffic accidents.

5. Dominant Facktor

Table 7. Dominant Accident Factors

ACCIDENT CHRONOLOGY	PROPOSAL
CHRONOLOGY 1	1. Track a. Traffic signs b. Speed limit sign c. Lane barrier (Median) 2. Human Behavior a. Counseling 3. Environment a. Improved visibility
CHRONOLOGY 2	1. Track a. Traffic signs b. Speed limit sign c. Lane barrier (Median) 2. Human Behavior a. Counseling 3. Environment a. Improved visibility
CHRONOLOGY 3	1. Track a. Speed limit sign b. Lane barrier (Median) 2. Human Behavior a. Counseling 3. Environment a. Improved visibility

ACCIDENT CHRONOLOGY	PROPOSAL
CHRONOLOGY 4	1. Track a. Lane barrier (Median) 2. Human Behavior a. Counseling 3. Environment a. Improved visibility
CHRONOLOGY 5	1. Track a. Lane barrier (Median) 2. Human Behavior a. Counseling 3. Environment a. Improved visibility
CHRONOLOGY 6	1. Track a. Lane barrier (Median) 2. Human Behavior a. Counseling
CHRONOLOGY 7	1. Track a. Lane barrier (Median) b. Speed limit sign 2. Human Behavior a. Counseling 3. Environment a. Improved visibility
CHRONOLOGY 8	1. Track a. Lane barrier (Median) b. Speed limit sign c. Traffic signs 2. Human Behavior a. Counseling 3. Environment a. Improved visibility
CHRONOLOGY 9	1. Track a. Lane barrier (Median) b. Speed limit sign c. Traffic signs 2. Human Behavior a. Counseling 3. Environment a. Improved visibility b. Anticipation of rain (Road geometry) 4. Vehicle a. Anticipate tire burst (Road geometry = Forgiving shoulder)

Table 8. Comparison of Proposed Conclusions

PROPOSED BASED ON ACCIDENT CHRONOLOGY	PROPOSED BASED ON SAFETY INSPECTION
1. trajectory **a. Traffic signs** **b. Speed limit sign** **c. Lane barrier** **2. Human** **a. Education on traffic safety** **b. Vehicle check before use** **3. Environment** **a. Environmental improvement (Anticipate rain)** **4. Vehicle** **a. Anticipation of tire bursts (Geometry road with a forgiving shoulder)**	1. Track a. Road Geometric Repair 2. Human Improved visibility

b. Instantaneous Speed Analysis

This analysis is used to determine the maximum, minimum and average speed limits of vehicles based on technical and traffic data, so that the analysis used is an 85% percentage analysis. Where 85% of the vehicle speed is running at or less than the 85th percentile speed. Thus, it can be seen in the table for the 85% vehicle speed limit obtained from the instantaneous speed survey at KM 212 Harmoko Bend.

Table 9. Speed of entry

NO	TRANSPORTATION TYPE	MAXIMUM SPEED	MINIMUM SPEED	AVERAGE SPEED	PERCENTILE 85
1	MC	82	53	67	75
2	LV	78	56	66	75
3	HV	58	40	47	56

Table 10. Velocity of Exit

NO	TRANSPORTATION TYPE	MAXIMUM SPEED	MINIMUM SPEED	AVERAGE SPEED	PERCENTILE 85
1	MC	78	40	54	65
2	LV	75	41	54	64
3	HV	67	32	50	58

Based on the analysis of the spot speed survey above, it is known that KM 212 Palembang-Jambi Cross Road, Musi Banyuasin Regency has a fairly high average speed. This is due to the function of the primary arterial road which is a Sumatran causeway and connects it with other areas, thus triggering motorized vehicle drivers to drive their vehicles at high speed. In this analysis, it can be seen that the motorcycle entering the Musi Banyuasin Regency has an average speed of 67 km/hour but the speed at the 85th percentile for motorcycles reaches a speed of 75 km/hour and it can be seen that the maximum speed of a motorcycle is 82 km/hour while the minimum speed of a motorcycle is 53 km/h. Likewise with other vehicles such as private cars, pick ups to transport goods through this road segment.

After obtaining the existing speed of the vehicle, then it is compared with the design speed. The design speed at KM 212 for the Palembang-Jambi Cross Road is 60 km/hour, the existing speed is higher than the design speed, so the vehicle speed is not in accordance with the design speed. This is because many drivers drive their vehicles at high speed so that it can cause traffic accidents.

c. Horizontal Alignment Analysis

1. Count Speed (V Speed)

In this study area, there is only one bend that becomes a problem, namely the Harmoko Bend. Therefore, the emphasis on the problem is only focused on that point to be analyzed in order to get the average vehicle speed (Vcount) which will be compared with Vexisting from the results of the spot speed survey analysis and Vplan = 60 km/hour based on the function of the road, namely the national road. An example of the calculation to get the initial Vcount is as follows:

V plan = 60 Km/Hours; e = 0,16; f = 0.153; R = 63,2 M

Asked : V count^2

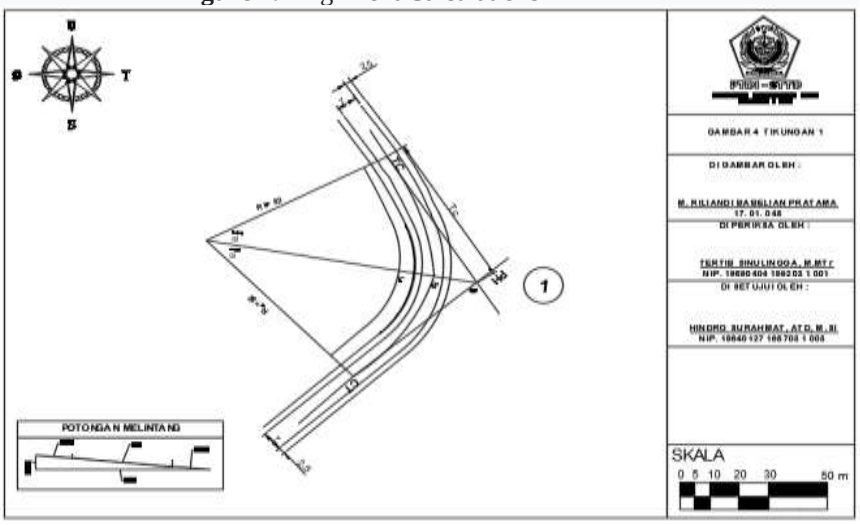
V count^2 = (e + f) x 127 R = $(0{,}09 + 0{,}116)x127\ x\ 63{,}2$

$=\sqrt{2.006{,}6}$ = 44,79 Km/Hours

= 45 KM/Hours

From these calculations, it can be seen the calculated speed of a vehicle and it can be concluded that the vehicle speed at the Harmoko Bend tends to have the potential to cause accidents. This is because the speed of the existing vehicle in the field (67 km/hour) is actually greater than the speed of the vehicle that should be (45 and 50 km/hour) from the calculation results based on the radius of the measurement results.

Figure 2. Alignment Calculations



d. Stop Sight Analysis

Table 11. Visibility

Plan Speed	Fm	d
30	0.4	25-30
40	0.375	40-45
50	0.35	55-65
60	0.33	75-85
70	0.313	95-110
80	0.3	120-140
100	0.285	175-210
120	0.28	240-285

Source: AASHTO 1990

Based on the survey data and calculations above, that the existing stopping visibility at KM 212 Harmoko Bend Spot on the Palembang-Jambi highway, Musi Banyuasin Regency is still not matched, because it still exceeds the standard stopping visibility for motorcycles and light vehicles entering and leaving the KM 212 Spot. Harmoko Bend, Musi Banyuasin Regency. So that it can cause traffic accidents at KM 212 Harmoko Bend Spot

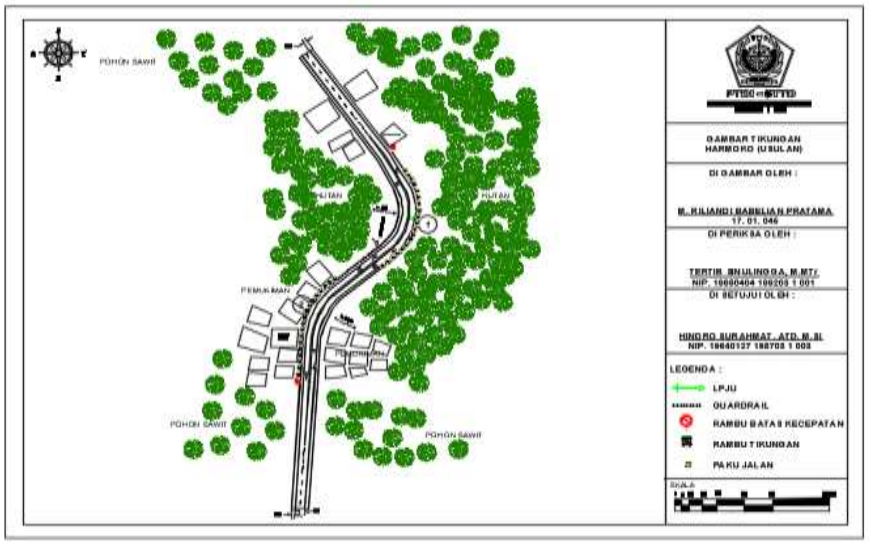
e. Countermeasures

1. Speed Management
   - Speed Limit Setting
   - Engineering Actions
2. Adding Road Equipment
   - Road Marking
   - Speed Limit Sign
   - Bend Signs
   - Noisy Ribbon
   - Road Nails
   - Delineator

3. Road Geometric Improvement
   - The Shoulder of the Way of Forgiveness
   - Addition of Median Road
   - Construction of Drains

f. Proposed Design

Figure 3. Proposed Design



5. Conclusion

Based on the results of the analysis and discussion above, the following conclusions can be drawn: Based on the analysis of accident characteristics from the Traffic Unit of Musi Banyuasin Regency in 2019, the number of accidents occurred was 9 accidents with 6 deaths, 8 seriously injured and 1 lightly injured. The factor causing the highest accident is the human factor and infrastructure. The proposed design for the placement of road equipment, especially signs, is adjusted to the average speed of motorized vehicles crossing KM 212 on the Palembang-Jambi Cross Road section. Recommendations for handling in an effort to improve the safety of the KM 212 Palembang-Jambi Cross road are in the form of speed management and complete road equipment.

To improve safety on the harmoko bend, the authors suggest: It is necessary to add, replace, and maintain road equipment facilities in accordance with road technical requirements by the Musi Banyuasin Regency Transportation Service. The road equipment is in the form of traffic signs, road medians, waterways, forgiving road shoulders. It is necessary to add road markings in accordance with the provisions in force by the Musi Banyuasin Regency Transportation Service. And it is necessary to conduct counseling, campaigns, training, as well as monitoring and controlling traffic compliance, by related parties to the general public, school students, and agencies located in Musi Banyuasin Regency so as to reduce the number of accidents at KM 212 Jalan Lintas Palembang- Jambi.

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[1] (PRESIDEN REPUBLIK INDONESIA, 2009). Law of the Republic of Indonesia Number 22 of 2009 concerning Road Traffic and Transportation.

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