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Risk Journey Management on Travel Routes in Indonesia

Rukman[1], Yogi Oktopianto[1], Iqbal Maulana[1], Anton Budiharjo[1], Sutardjo[1]
[1] Road Transport Safety Polytechnic

Abstract

In the last three years (2018 – 2020), on the tourist route of the Subang - Lembang road section, West Java, there have been 193 traffic accidents that caused a death toll of 28 people. The geographical condition of the Subang - Lembang road section is mountainous and gorge, so there are many climbs, descents, and bends. The purpose of this study is 1) to find out accident-prone points (blackspots), 2) to know the safety defense of road infrastructure and road equipment, and 3) to know the characteristics of vehicles involved in traffic accidents. This study used the method of several parameters of the number (rate) of accidents with data representing the condition, potential, and characteristics of accidents, road geometrics, and harmonization of the road equipment. The results showed three (3) points prone to traffic accidents (blackspots), namely on the Tangkuban Perahu - Cicenang, Ciater, and Cijambe - Gunungtua road segments. The highest infrastructure safety deficiency in the Ciater and Tangkuban Perahu – Cicenang segments (climbs and derivatives of emen) gradient conditions exceed the technical standard of 70%-100% with a gradient measurement result of 15.48% with a risk value of 500 and a Very Dangerous Risk (SB) category. Bend radius aspect with a measuring result of 19.45% with a risk value of 180 risk categories Quite Dangerous (CB). Meanwhile, other aspects are curve visibility, lane width and shoulder of the road, warning and prohibition signs, and inadequate guardrails or road user safety fences so that they have the potential for traffic accidents at these road points with a risk value of 320 and are in the Hazard category (B). Vehicles involved in traffic accidents are heavy and common types of vehicles.

Keywords: *Safety, Blackspot, Road and Road Equipment*

INTRODUCTION

Traffic accidents occur at any time, not every time, but the impact is fatal because it can cause death, permanent serious injuries, and minor injuries. It also causes losses, both material and immaterial. Road safety is a global issue because every year in the world, around 1.3 million people die and more than 25 million people are permanently seriously injured due to road traffic accidents. Seventy-five percent of this occurs in developing countries, including Indonesia, so in 2004 the World Health Organization (WHO) raised the theme "Road Safety is No Accident."This is reasonable because it is estimated that in 2020, traffic accidents will be the third leading cause of death worldwide after cancer and stroke (Directorate of Land Transport Safety, 2007:1).

From 2018 to 2020, based on data from the West Java Regional Police Satlantas, 193 accidents on the Subang - Lembang road section resulted in 28 deaths. The geographical condition of the Subang - Lembang road section is mountainous and gorge, so there are many climbs, descents, and bends. This study was conducted using several parameters of the number (rate) of the accident with data representing local conditions, potentials, and characteristics.

Corresponding author
Rukman, rukman@pktj.ac.id

The purpose of this study was to determine accident-prone points (blackspots), to determine the characteristics of vehicles involved in traffic accidents, to know the safety deficiencies of road infrastructure and road equipment on the Subang - Lembang road section and to provide strategic solutions for handling accident-prone traffic locations on that road.

The location of this study was conducted on the Subang – Lembang Road Section, West Java, Indonesia (Emen climbs and descents). The research will be carried out to handle locations prone to traffic accidents.

LITERATURE REVIEW

A. Road Classification System

Law of the Republic of Indonesia Number 38 of 2004 concerning Roads explains the meaning and grouping of roads. The road is a land transportation infrastructure that includes all parts of the road, including complementary buildings and equipment intended for traffic, which is at ground level, above ground level, below ground and/or water level, and above water level, except railways, lorry roads, and cable roads. Roads are grouped into two designations, namely public roads and special roads. A public road is a road intended for public traffic in the context of the distribution of goods and services needed. The explanatory section of law number 38 of 2004 explains that special roads are roads within port areas, forestry roads, plantation roads, irrigation inspection roads, roads in industrial areas, and roads in residential areas that have not been handed over to the government.

B. Traffic Accident

Law Number 22 of 2009 concerning Road Traffic and Transportation article 1 point 24 explains the definition of a traffic accident as an unexpected and accidental road accident involving vehicles with or without other road users resulting in human casualties and/or property losses. Article 229 regulates the classification of traffic accidents:

1. Minor Traffic Accidents are accidents that result in damage to vehicles and/or goods.
2. Moderate Traffic Accident is an accident that results in minor injuries and damage to vehicles and/or goods.
3. A serious traffic accident results in the victim's death or serious injury.

RESEARCH METHOD

This research is a descriptive study with a quantitative approach. Primary data was obtained from the results of traffic and road surveys using Hawkeye 2000 series survey car, digital camera, and walking measure at the research location; then, the secondary data, namely accident data obtained from the Police and Transportation Agency of Subang Regency, which are presented in the form of numbers and then analyzed and described.

A. Research sites

The research location is on the Subang - Lembang highway, the provincial road that is the primary access to travel from outside the city to the cities of Subang and Lembang and vice versa. The geographical conditions along the road section are uphill and winding. The length of the Subang - Lembang road section is 45 kilometers.

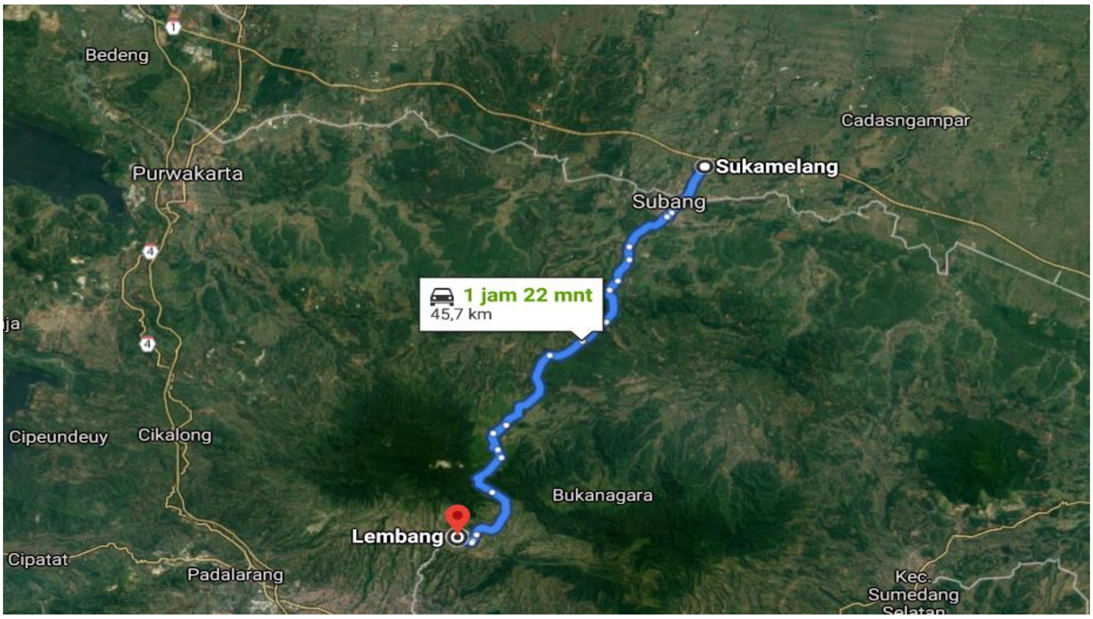

Figure 1. Research Road Map (Subang - Lembang)

B. Method of collecting data

Primary data contains road inspections at accident-prone locations obtained from field surveys, needed in efforts to handle accident-prone locations, field surveys using Hawkeye 2000 series survey cars, digital cameras, walking measures, and water passes. The secondary data needed as analysis material in this study is accident data from 2018 to 2020 obtained from the West Java Regional Police and the Subang Police, namely traffic accident data in the form of general data and traffic accident reports. Data from the Subang Transportation Agency is average daily traffic data.

C. Data analysis method

The analysis methods used are quantitative and qualitative data analysis including:

1. Accident Rate Method (TK). A weighting of the number of accidents refers to the average daily traffic.

$$TK = \frac{\text{Fk x } 100^2}{\text{LHRT x n x L x 365}}\text{TK} \qquad (1)$$

2. Determination of accident-prone locations using quality control statistics as A UCL (Upper Control Limit) control-chart.

$$\text{UCL} = \lambda + [2.576 \sqrt{(\lambda/m)}] + [0{,}829/m] + [1/2m] \qquad (2)$$

3. Blacksite Handling Efforts.

   The handling efforts are carried out after preparing a priority order for the level of vulnerability. The priority is then to carry out road safety inspections to handle black sites, namely by knowing the hazards at the black site location and then providing recommendations on hazards.

4. Road Safety Deficiency Analysis
   Based on assumptions built from the processing of accident event data at blackspot locations in several regions in Indonesia, it can be classified as the value of the opportunity for road infrastructure safety deficiency to the potential for accident events on the road, as stated in Mulyono et al. (2009) and shown in the following Table:

Table 1. Opportunities for Road Infrastructure Safety Deficiencies against Potential Road Accidents Based on Field Measurement Data

Results of Measuring the Degree of Deviation on Road Geometrics	Quantitative Value
The measurable difference in the field is less than 10% against the technical standard	1
The measurable difference in the field is less than 10% - 40% against the technical standard	2
The measurable difference in the field is less than 40% -70% against the technical standard	3
The measurable difference in the field is less than 70% -100% against the technical standard	4
The measured difference in the field is greater than 100% against technical standards	5

Source: Mulyono et al., (2009)

Mulyono et al. (2009b; 2009c) have created simple criteria as an approach to defining accident-prone locations (blackspots) on the highway quantitatively and qualitatively based on road and geometric equipment data, as shown in the following Table 2:

Table 2. Impact of Damage to Roads and road equipment based on Potential Accident-Prone Locations

Results of the evacuation of victims of road driving accidents	Qualitative value	Quantitative value
In the parameters there are not enough values dangerous, dangerous, and very dangerous	Very light	10
In the parameter there are only sufficiently dangerous values with an amount of less than 5 points	Light	20
In the parameters there are quite dangerous values of more than 5 points	Keep	40
In the parameter there is a malicious value	Heavy	80

In the parameter there is a very dangerous value	Very heavy	100

Source: Mulyono et al. (2009)

Mulyono et al. (2009b; 2009c) stated that the risk value of each deficiency that has been found could indicate how urgency the response to be handled must be. The calculation of the risk value is formulated as follows:

$$\text{Risk Value} = \text{Opportunity Value} \times \text{Basic Values} \quad (3)$$

Table 3. Value and Risk Categories, along with the Level of Handling Road Infrastructure Safety Deficiencies

Risk analysis		**Importance of handling**
Assess the risk	**Risk categories**	
< 125	Harmless (TB)	Regular monitoring with scheduled road safety inspections at points with potential accidents
125 – 250	Moderately dangerous (CB)	Needs unscheduled technical handling based on the results of road safety inspections at the scene and its surroundings
250 – 375	Dangerous (B)	Needs scheduled technical handling a maximum of 2 (two) months from the results of the audit
>375	Very dangerous (SB)	It needs total technical handling with relevant stakeholders for a maximum of 2 (two) weeks from the time the results of the road safety audit are approved

Source: Dirjen Bina Marga (2007) and Mulyono et al. (2009)

FINDINGS AND DISCUSSION

A. Traffic Accident Analysis using TK and UCL methods

Accident calculation analysis using the Accident Rate (TK) and Upper Control Limit method (UCL) on the Subang – Lembang road to obtain blackspots in this study in detail described as follows:

Table 4. Accident Analysis Results Accident Rate (TK) and Upper Control Limit (UCL) method

No.	Road Segment	2020	Number of accidents	Road Length (Km)	Vol traffic	Accident Factor	Accident Rate	Lambda	UCL	UCL Kindergarten	Information
1	Tangkuban Perahu - Cicenang	9	9	7.7	10196	9	282.66	195.73	218.91	63.74	Blackspot
2	Ciater	7	7	2.2	10196	7	598,48	195.73	223.83	374.64	Blackspot

3	Palasari - Curugrendeng	5	5	6.3	10196	5	106.62	195.73	218.54	-111.91	Not Blackspot
4	Jalancagak - Bunihayu	7	7	12	10196	7	109.72	195.73	221.77	-112.05	Not Blackspot
5	Tambakan	6	6	9.8	10196	6	98.70	195.73	220.08	-121.37	Not Blackspot
6	Cijambe - Gunungtua	7	7	4.3	10196	7	306.19	195.73	219.14	87.05	Blackspot
7	Tanjungwangi	4	4	5.5	10196	4	78.16	195.73	218.57	-140.40	Not Blackspot
8	Praung	1	1	4.9	10196	1	5.48	195.73	218.76	-213.27	Not Blackspot
9	Ranggawulung - Pasirkareumbi	7	7	7.5	10196	7	175.55	195.73	218.83	-43.28	Not Blackspot
AMOUNT			53	60.2	10196	53			77.57		
AVERAGE			5,889				195.7				

On the Subang - Lembang road section, there are three (3) traffic accident-prone points (blackspots), namely the **Tangkuban Perahu - Cicenang, Ciater, and Cijambe - Gunungtua** road segments.

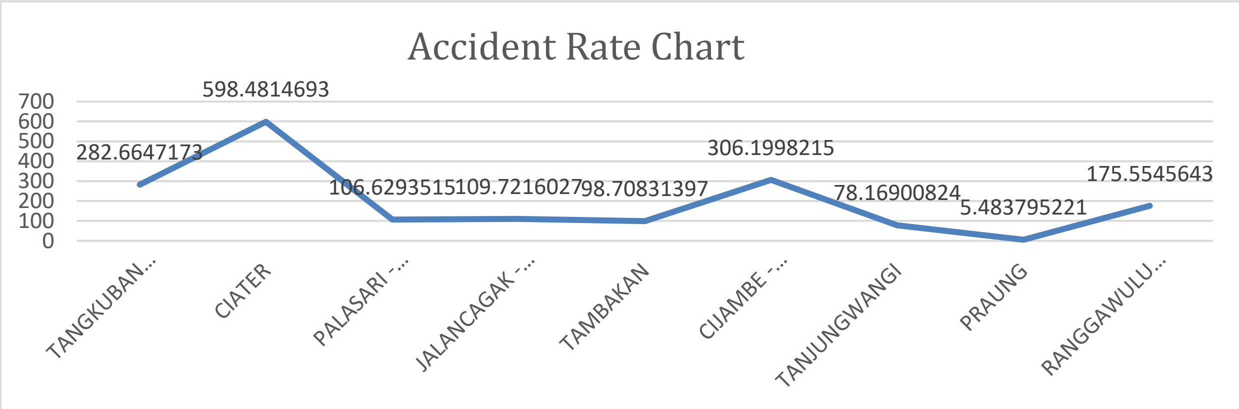

Figure 2. Graph of Accident Rates for Subang - Lembang Roads

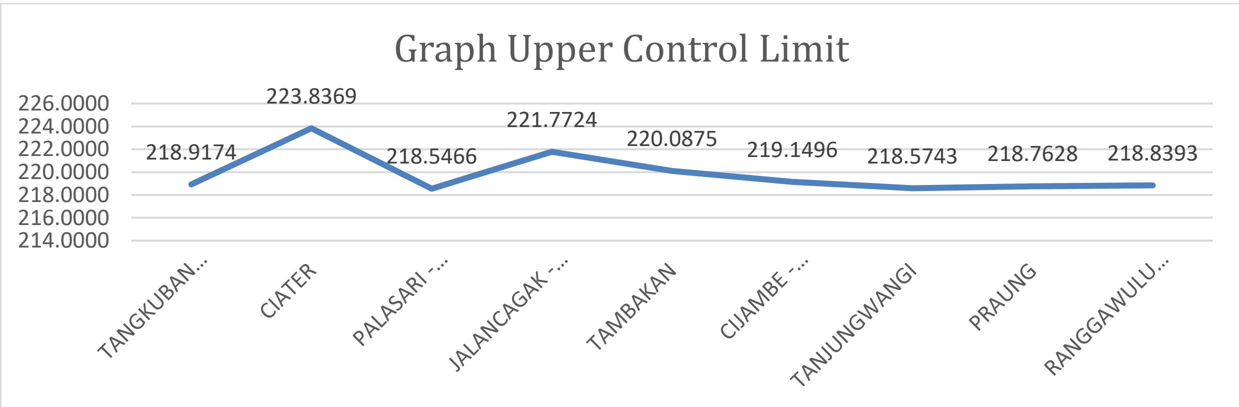

Figure 3. Graph *of Upper Control Limit* Subang - Lembang Road Section

In the graph analysis of the accident rate and upper control limit, the highest road segment is on the **Ciater section**. The accident rate value is 598.48 (100 JPKP), with one hundred million vehicle trips per kilometer. The value of the upper control limit is 223,83. Segments of road segments with accident rates above the UCL line are defined as accident-prone locations. Namely the Tangkuban Perahu – Cicenang, Ciater and Cijambe – Gunungtua roads.

B. Road Infrastructure Deficiency Analysis

Analysis of infrastructure deficiency obtained the highest risk value of traffic accidents on the Subang - Lembang road on the following roads:

Table 5. The greatest opportunity value of safety deficiencies of geometric aspects of road infrastructure against its technical standards

Beginning of station (km)	End of station (km)	Grades (%)	Cross Slope (%)	Horizontal Curvature 1/km	Vertical Curvature 1/km	Latitude (deg)	Longitude (deg)	Altitude (m)
9	9	11.71	2.4	10.88	0.32	-6.63257	107,723	339.4
10.3	10.4	12.31	-2.06	-2.66	0.5	-6.64366	107.7242	419.4
21.1	21.1	12.03	-7.25	-4.58	-0.06	-6.70981	107.6719	791.6
23.5	23.8	12.44	0.22	0.06	0.19	-6,72541	107.6571	950
24.4	24.4	10.68	-6.57	-4.04	-0.1	-6,72959	107.6541	997.7
25.4	25.5	10.63	3.13	2.95	0.06	-6,73652	107.6478	1086.2
25.8	25.8	10.84	-8.94	-12.16	-0.21	-6,73659	107.6458	1106.9
26.9	27.2	10.47	2.5	4.1	0.08	-6.74623	107.6467	1161.8
29.3	29.5	11.86	-1.15	-1.05	-0.16	-6.76253	107.6442	1315
29.9	31.9	12.66	2.2	1.84	0.09	-6.76566	107.6426	1364.9
32	32	-10.9	0.1	1.06	-0.21	-6,77659	107.6398	1463.9
34.5	34.5	-11.13	-4.14	0.32	-0.19	-6.79133	107.6545	1286.1
37.7	37.7	10.71	-4.69	-3.22	0.12	-6.80744	107.6392	1214,4

The results of measuring using the Gypsitrac tool in the survey using the Hawkeye 2000 series car by producing geometric road parameters, namely gradient, slope, horizontal alinyemen, and vertical alinyemen. The measurable difference in the field is between 70% - 100% of the technical standards, namely in station 10.3, station 24.4 to 29.9, and 37.1. It can be concluded that the geometric deficiencies of the road are found in the Ciater and Tangkuban Perahu – Cicenang road segments, which is at the Quantitative Value of 4, meaning that there are 10-15 accidents per year at the location. Road Safety Audit on geometric road deficiencies and harmonization of road equipment station 28.5 to 30.1 and station 37.1 to 37.4 Ciater and Tangkuban Perahu – Cicenang, namely on the Emen incline and descent.

From the results of safety deficiencies in the Ciater segment and the Tangkuban Perahu - Cicenang segment (uphill and downhill Emen), the *gradient* conditions exceed the technical standard, namely 15.48% with a risk value of 500 in the **Very Dangerous Risk (SB)** category. The aspect of bend radius with a measuring result of 19.45 % with a risk value of 180 risk categories **Fairly Dangerous (CB).** Meanwhile, other aspects, namely the visibility of bends, the width of lanes and road shoulders, warning and prohibition signs, and *guardrails* or safety fences for road users, are not adequate, so they have the potential for traffic accidents at that point with a risk value of 320 in the **Hazard category (B).**

Table 6. The results of the road infrastructure safety audit of the Ciater and Tangkuban Perahu – Cicenang segments (Emen climbs and descents)

audited aspects		Safety technical standards	Measurement results and observations	Deviation from standard (%)	Opportunity value	Accident Factor			Impact value	risk value	Risk Category
Aspect	Unit					Die	Serious injury	Minor injuries			
Grade	%	±10	15.48	5	5	14	10	9	100	500	SB
Horizontal Curv.	Deg/km	±31.25	19.45	3	3	14	10	9	60	180	CB
Visibility	condition	not harmful	3	80	4	14	10	9	80	320	B
Lane Width	m	3.5	3	20	4	14	10	9	80	320	B
Road Shoulder Width	condition	2	4	10	4	14	10	9	80	320	B
Warning sign	conditions %	100	3	40	4	14	10	9	80	320	B
Prohibition Sign	conditions %	100	3	80	4	14	10	9	80	320	B
Guardrail and Delineator	conditions %	100	4	80	4	14	10	9	80	320	B

C. Safety Improvement Recommendations

Based on the Value and Risk Category along with the Level of Handling Road Infrastructure Safety Deficiencies, in the Ciater segment and the Tangkuban Perahu – Cicenang segment (climbs and emen derivatives) for the gradient aspect with a risk value of 500 and the Very Dangerous Risk (SB) category, it is necessary to take total technical handling with relevant stakeholders a maximum of 2 (two) weeks from the time the results of the road safety audit are approved. For the bend radius aspect with a risk value of 180 and the Sufficiently Hazardous (CB) risk category, it is necessary to carry out unscheduled technical handling based on the results of road safety inspections at the scene and its surroundings. For aspects of corner visibility, lane width and shoulder of the road, warning and prohibition signs, as well as guardrails or road user safety fences with a risk value of 320 and hazard category (B), it is necessary to schedule technical handling a maximum of 2 (two) months from the results of the audit.

In addition to the recommendations above, the researcher also proposes short-term recommendations, namely:

1. The Subang Regency Transportation Service and Subang Police Station make warnings and appeals to tourism vehicle parking lots, so that road users check the condition of the vehicle before making the return journey from Ciater and Tangkubang Perahu tours
2. The Transportation Service of West Java Province makes signals and warnings, namely the installation of warning signs 1 km before the location of the incident, namely warning signs with audio and electronic writing in contrasting colors with the sentence/writing "heavy vehicles use low gear, reduce speed."

Long-term recommendations for the Office of Highways and Spatial Planning of West Java Province are widening the road and adding special climbing routes for heavy or low-speed vehicles. *Gradient* improvement on climbs and descents in accordance with specified technical standards.

CONCLUSION

A. Conclusion

On the Subang-Lembang road section, there are three (3) traffic accident-prone points (*blackspots*), namely the Tangkuban Perahu - Cicenang, Palasari - Curug Rendeng, and Cijambe - Gunungtua road segments. From the results of the safety deficiency in the Ciater and the Tangkuban Perahu - Cicenang segment (uphill and downhill Emen), the *gradient* condition exceeds the technical standard of 15.48% with a risk value of 500 in the Very Dangerous Risk (SB) category. The aspect of bend radius measuring 19.45 % with a risk value of 180 risk categories is quite dangerous (CB). Meanwhile, other aspects are the visibility of bends, the width of lanes and road shoulders, warning and prohibition signs, and inadequate *guardrails* or safety fences for road users so that they have the potential for traffic accidents at that point with a risk value of 320 in the Hazard category (B). The types of vehicles that often experience accidents on the Subang-Lembang road segment in the last three years are heavy vehicles and public transportation.

B. Suggestion

Safety is an implementation, not a slogan. Therefore, the researcher suggests a follow-up to the recommendations of this study. There is also a need for a more comprehensive follow-up study involving relevant agencies to obtain a better solution for handling accidents on the Subang - Lembang tourist route.

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