

# Road Safety Assessment of Banda Aceh - Krueng Raya (Krueng Cut - Baitussalam Toll Gate) Based on User Perception

Afzal Mustaqim DM<sup>1</sup>, Sofyan M. Saleh<sup>1</sup>, Yusria Darma<sup>1\*</sup>

<sup>1</sup>Department of Civil Engineering, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

\*Corresponding author: [yusriadarma@usk.ac.id](mailto:yusriadarma@usk.ac.id)

**Abstract.** The Banda Aceh-Krueng Raya Road is a national road and a major arterial road that plays a role in the economic growth of Aceh. The existence of this road is vital because it is the main access to the Sibanceh Toll Road (the end of the Trans Sumatra Toll Road) from urban areas and supports the smooth distribution of goods through the Malahayati seaport. Based on previous research, the cause of accidents on the Banda Aceh - Krueng Raya Road section is a combination of physical and environmental factors. This study aims to determine the geometric conditions and perceptions of motorists who have passed or live around the road section both before and after the Baitussalam Toll Gate became operational. The research used geometric surveys and distributed questionnaires to 290 respondents. The questionnaire data were processed using the Principal Component Analysis (PCA) factor analysis modeling method using SPSS software. The results of the observation obtained road geometric conditions in most of the reviewed segments are not in accordance with road safety standards. Data analysis obtained factors that greatly affect the accident according to the perception of the driver is driving skills factor, potential damage and maintenance of road facilities factor, driving behavior and habits factor, vigilance and concerns about traffic conflicts factor, and finally driving awareness factor.

## 1 Introduction

Traffic accidents are important for evaluating road safety. To reduce accidents, it's important to identify potential causes, such as road conditions. Anonymous (1997) suggests conducting road safety audits to improve geometric design, complementary buildings, and support facilities that might cause accidents [3]. These audits involve comprehensive and systematic road inspections. The population of Banda Aceh City grows at a rate of 1.02% annually, but the city center is not able to meet housing needs due to high population density. Therefore, people shift to outskirts like Baitussalam District with a growth rate of 2.95%. Baitussalam Sub-district is accessible and close to the city center, making it a developing area of interest. Laksamana Malahayati road connects the area.

The Banda Aceh - Krueng Raya Road is a crucial national and primary arterial road that contributes significantly to the economic growth of Aceh. It serves as an important access point to the Sibanceh Toll gate and facilitates the seamless distribution of goods through the Malahayati seaport. According to Budiani's research, accidents on this road are caused by a combination of physical and environmental factors [8]. Despite being located in a residential and commercial area, the Banda Aceh Road - Baitussalam Toll Gate is heavily used due to its proximity to the Sibanceh tollgate, resulting in a high number of traffic accidents.

Traffic conflicts on a road section involving heavy and small vehicles were discussed in Sisca's dissertation [25]. The government as the road organizer is expected to provide safe roads, as emphasized by Laras et al's research [22]. This is supported by positive public perception towards the construction of toll roads.

This research examines the opinions of road users regarding road safety on the Banda Aceh - Baitussalam Tollgate Road section before and after the Sibanceh Toll Road opens. Surveys were given to vehicle owners and drivers who regularly use the road, and data was analyzed using the Principal Component Analysis (PCA) method with SPSS software. The study also included direct measurements of road conditions, signage, markings, and lighting, which will be presented in the AKJ Checklist sheet for Road Safety Analysis.

The study aims to determine if the Banda Aceh Road - Baitussalam Toll Gate section meets applicable standards regarding geometric conditions, markings, signs, and lighting equipment. Additionally, it seeks to assess the public's perception of road safety along this section before and after the Sibanceh toll road is operational. The study's findings will serve as a reference for addressing the high number of accidents in the Banda Aceh - Baitussalam Toll Gate Road section. Therefore, it provides insight into how to mitigate risk factors in the area.

## 2 Methodology

There are two data collection methods, namely respondent perception data through questionnaires and road geometric data. The distribution of questionnaires is intended to find out how the respondents' perceptions of road safety on the Banda Aceh Road - Baitussalam Toll Gate, Baitussalam District, Aceh Besar Regency. Previous research data related to traffic volume and vehicle speed on the Banda Aceh-Krueng Raya Road section.

In the first stage, road geometric measurements were carried out on the road segments under review to obtain information related to road geometric conditions which included measurements of road width and lanes. The second stage is to survey the volume of vehicle traffic by counting the number of vehicles passing through the road segment, taking into account the factors of the number of vehicles, direction of movement, observation time and peak hour period in units of passenger cars (smp).

The first surveyor was tasked with observing heavy vehicles (HV) and light vehicles (LV), the second surveyor was tasked with observing motorcycles (MC) and non-motorized vehicles (UM). The sampling technique used in this study is based on the non-probability sampling method, which is a sampling technique that does not provide equal opportunities or opportunities for each element or member of the population to be selected as a sample, using a purposive sampling approach.

Half of the respondents are people who own vehicles who live around the road and the other half (150 questionnaires) will be distributed to motorists who have crossed the road such as truck drivers, buses and other vehicles. Data on geometric conditions, markings, signs and lighting equipment on road sections are applied directly to road conditions in the study area will be focused on the findings accompanied by identification of road sections and other supporting facilities using the AKJ (Road Safety Analysis) 2005 checklist sheet. For the field survey on the distribution of questionnaires, the processed data were tested for Bartlett, Kaiser Meyer Oikin (KMO), and Measure of Sampling Adequacy (MSA).

## 3 Results and Discussion

### 3.1 Road Safety Assessment

Table 1 shows the result of surveys conducted in three locations, namely Banda Aceh - Krueng Raya Road, Baitussalam District (STA 5+750 - STA 6+000), Baitussalam District (STA 6+00 - STA 10+000) and Baitussalam District (STA 10+000 - STA 10+250).

**Table 1** Road Geometric Measurements

Street Name	Road Type	Road Length (m)	Road Width (m)	Road Median Width (m)	Road Shoulder Width (m)
Banda Aceh - Krueng Raya Road (STA 5+750–6+000)	Four two-way lanes with median (4/2D)	250	7	3,5	-
Banda Aceh - Krueng Raya Road (STA 6+000–10+000)	Two-lane undivided two-way (2/2 UD)	4.000	7	-	2
Banda Aceh - Krueng Raya Road (STA 10+000–10+250)	Four two-way lanes with median (4/2D)	250	7	1	-

Table 2 shows many parts of the road are not up to the standard.

**Table 2** Geometric Observations on Banda Aceh - Krueng Raya Road  
 (STA 5+750-STA 6+000)

Observation and Measurement	Unit	Safety Engineering Standards*	Measurement and Observation Results	Deviation from Standard (%)
Rumaja (Road Benefit Area)	m	13	17,5	25,7
Rumija (Right-of-Way)	m	15	24	37,5
Ruwasja (Road Surveillance Section)	m	15	24	37,5
Road Body	m	11	14	21,4
Road Shoulder	m	1,5	-	-

**Table 3** Geometric Observations on Banda Aceh - Krueng Raya Road  
 (STA 6+000-STA 10+000)

Observation and Measurement	Unit	Safety Engineering Standards*	Measurement and Observation Results	Deviation from Standard (%)
Rumaja (Road Benefit Area)	m	13	14	7,1
Rumija (Right-of-Way)	m	15	14	-7,1
Ruwasja (Road Surveillance Section)	m	15	14	-7,1
Road Body	m	11	7	-57,1
Road Shoulder	m	1,5	2	-

**Table 4** Geometric Observations on Banda Aceh - Krueng Raya Road  
 (STA 10+000-STA 10+250)

Observation and Measurement	Unit	Safety Engineering Standards*	Measurement and Observation Results	Deviation from Standard (%)
Rumaja (Road Benefit Area)	m	13	17,5	25,7
Rumija (Right-of-Way)	m	15	20	25,0
Ruwasja (Road Surveillance Section)	m	15	22	31,8
Road Body	m	11	14	21,4
Road Shoulder	m	1,5	-	-

According to the observations on the 4.5-kilometer road section, the Banda Aceh - Krueng Raya Road (STA 6+000-STA10+000) has deviations that do not meet the standards, except at the beginning and end of the inspection. This non-standard construction may contribute to accidents on the section.




**Table 5** Observation and Measurement Visibility Conditions

Observation and Measurement	Unit	Engineering Standards Safety*	Measure Results and Observation	Deviations from Standard (%)
Stopping Visibility	m	32,2	34,65	7,61
Viewing Distance	m	175	180,23	2,99

\*Ministerial Regulation of Public Works and Housing No. 19/PRT/M/2011

The research location's speed survey yielded an average speed of 34.7 km/h, and both stopping and preparing visibility measurements were found to be above the technical standard with deviations of 7,61% and 2.99%, respectively.

**Table 6** Road Geometric Conditions

Road Name	Photo
Banda Aceh-Krueng Raya Road (STA 5+750-STA 6+000)	
Banda Aceh-Krueng Raya Road (STA 6+000-STA 10+000)	
Banda Aceh-Krueng Raya Road (STA 10+000-STA 10+250)	

The direct observation on the test site revealed the presence road surface markings, but some of these markings are fading in certain sections of Baitussalam District (STA 6+00 - STA 10+000), while the Baitussalam Toll Gate (STA 10+000 - 10+250) has proper road surface markings. Traffic signs and street lights are inadequate and minimal on all sections of the road. These conditions need to be improved because it is crucial for aiding motorist navigate the road.

### 3.2 Traffic Volume

The traffic volume survey was conducted on June 25th and 26th, 2023 on a holiday (Sunday) and a weekday (Monday). Survey data was collected at three-time ranges during peak hours: 7:00-09:00 am, 12:00-2:00 pm, and 4:00-6:00 pm, with 15-minute intervals between each observation. These time ranges are considered to represent the time span during peak hours.

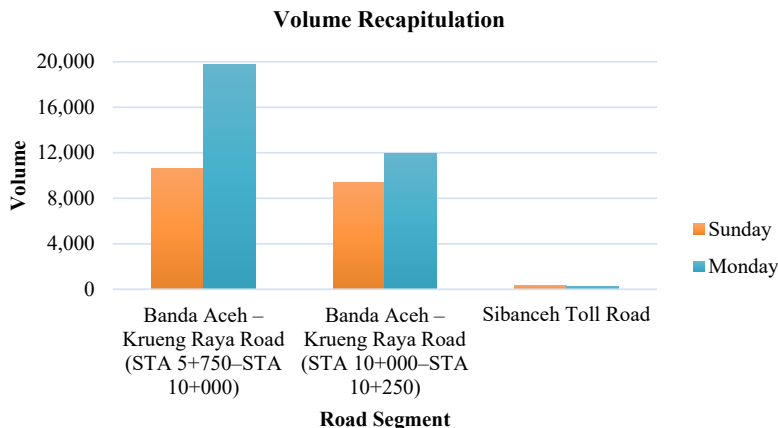


Figure 1 shows the recapitulation of the survey on the three road segments.

### 3.3 Respondent Characteristics

A study on traffic safety perception surveyed 290 individuals, including vehicle owners residing near the review road section, and motorists passing through the area. The questionnaire included sections on respondent characteristics, travel characteristics, and perceptions. Figure 2 shows 62% of respondents are male and 38% are female. Figure 3 shows the age group of 30-39 years old (36%) is the highest percentage of respondents, followed by the age group of 17-29 years old (31%), the age group of 40-50 years old (27%) and the age group of more than 50 years old (16%) as the lowest percentage of respondents. Figure 4 shows that 48% of respondents has undergraduate degree, 27% has postgraduate degrees, 16% has upper secondary education and 9% has associate’s degrees. Figure 5 shows self-employed (29%) as the most dominant occupation of respondents, followed by civil servant (26%), private-sector employee (15%), others (25%) and student (5%) as the lowest percentage. Figure 6 shows almost half of respondents (47%) have two types (A & C) of driving licenses, 29% has driving license C, 22.9% has driving license A, 1.8% has driving license for heavy vehicle (B1 & B2) and 7.9% has no driving license. Figure 7 shows that 53.2% of respondents passing through the road for work, 37.1% for tourism, 17.6% for commute to home, 15.1% for business and 6.8% for other purposes. Figure 8 shows 47% of respondents drive cars to travel, 42% ride motorcycles, 6% drive trucks and only 5% use public transportation. Figure 9 shows that 80% of respondents drive every day, 7% drive 2-3 times a week, 4% drive 2-3 times a month, 8% drive rarely and only 1% has other driving frequencies.

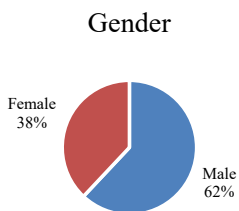


Figure 2 shows the Type of Gender

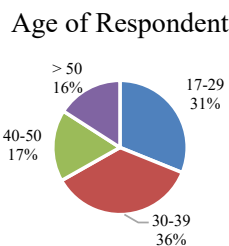
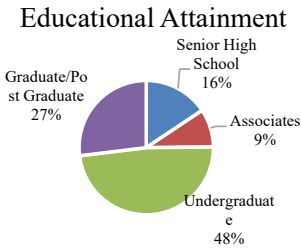
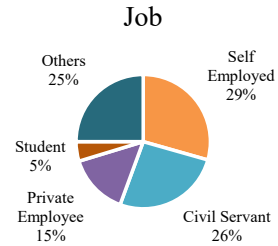


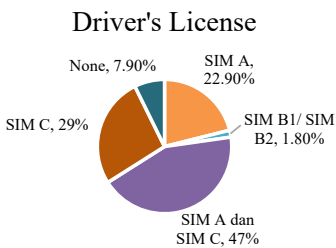
Figure 3 shows the Age of Respondent



**Figure 4** shows the Type of Education

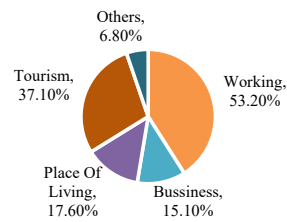


**Figure 5** shows the Respondents' Jobs

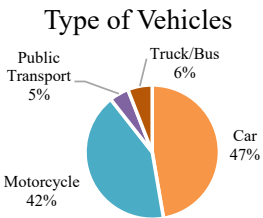


**Figure 6** shows the Type of Driver's License

### Movement of Respondents

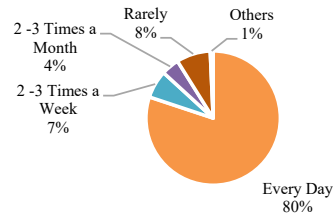


**Figure 7** shows the Movement of Respondents



**Figure 8** shows the Type of Vehicles

### Driving Frequency



**Figure 9** shows the Driving Frequency

### 3.4 Respondent Perception

The result of questionnaire from 290 respondents obtained varied answers. It shows variable Q21 has the highest average value, with an average value of 3.70. Variable Q9 has the lowest average value, with an average value of 1.38. The average respondent has answered the questionnaire with an average value of 2.73.

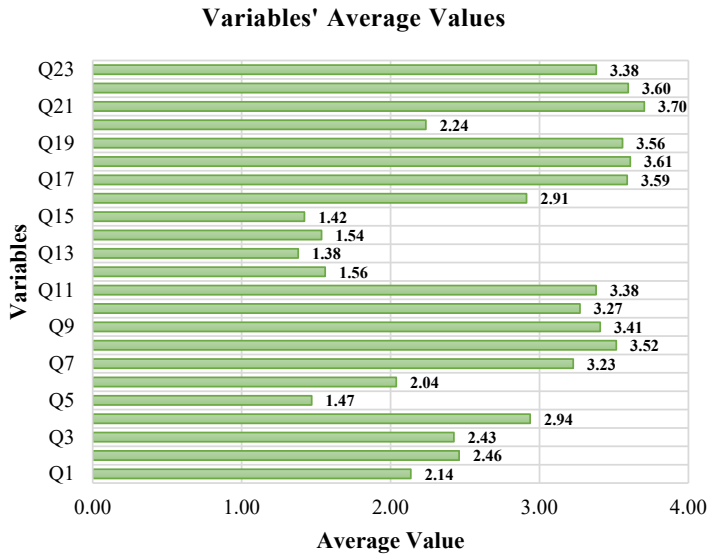


Figure 10 shows the average value of Respondent Perception.

**3.5 KMO and MSA Values**

Table 7 shows the KMO value obtained is 0.829, indicating the adequacy of the sample. The KMO and Bartlett's test number (shown in chi-square value) is 2145.494 with a significance value of 0.000, meeting the significance requirement <0.05 which indicates a correlation between variables and suitability for further processing. Table 8 shows Measure of Sampling Adequacy (MSA) test results of all variables with value > 0.5. These results aim to measure homogeneity between variables and filter between variables.

**Table 7 Results of KMO and Bartlett's Test Values**

<b>KMO and Bartlett's Test</b>		
<i>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</i>		0,829
<i>Bartlett's Test of Sphericity</i>	<i>Approx. Chi-Square</i>	2145,494
	<i>df</i>	253
	<i>Sig.</i>	0,000

**Table 8 MSA Test Results**

Variables	MSA Value
Q1	0,737
Q2	0,774
Q3	0,772
Q4	0,842
Q5	0,695
Q6	0,838
Q7	0,855
Q8	0,867
Q9	0,862
Q10	0,847
Q11	0,866
Q12	0,727

**Table 8 MSA Test Results**

Variables	MSA Value
Q13	0,713
Q14	0,737
Q15	0,720
Q16	0,779
Q17	0,844
Q18	0,875
Q19	0,849
Q20	0,821
Q21	0,892
Q22	0,844
Q23	0,869

### 3.6 Total Variance Explained

Table 9 shows that the components that have eigen value > 1 have a total variance of 55.53%, namely components 1 to 5. Components with eigen value > 1 are then selected and extracted to get the most influential indicators for each selected factor.

**Table 9 Extraction Sums of Squared Loadings**

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	5,365	23,324	23,324
2	3,025	13,152	36,476
3	1,777	7,724	44,200
4	1,529	6,648	50,848
5	1,077	4,681	55,530

### 3.7 Form Factor

Table 10 shows 5 factors affecting public perception of road safety on Banda Aceh - Krueng Raya Road which are the factor of driving skills and driving behavior by 23.32%, potential damage and maintenance of road facilities by 13.15%, driving behavior and habits by 7.72%, vigilance and concern about traffic conflicts by 6.64%, traffic conflicts by 6.64% and driving awareness by 4.68%. These 5 factors explain 55.53% of the total variance while the rest is not studied.

**Table 10 Form Factors**

Factor Names	Indicators	Variance
<b>Driving Skills and Behavior in Driving</b>	Slowing down when driving in the rain (Q17)	23,32%
	Reducing speed when passing through unsignalized intersections (Q18)	
	Going against the grain increases accident risk (Q19)	
	Driving more carefully at night (Q21)	
	Using cell phone while driving increases risk accident (Q22)	
	Smoking, eating or drinking while driving increases the risk of accident (Q23)	



	Heavy vehicles transporting phase materials Sibanceh Toll Road construction increases accident risk (Q4)	
<b>Potential Damage and Maintenance of Road Facilities</b>	The presence of ETLE camera (Electronic ticketing) at the Baitussalam Toll gate intersection after operation to reduce accidents (Q7)	13,15%
	Repair of road body and shoulder damage improve road safety (Q8)	
	Enforcement of vehicle speed restrictions (Q9)	
	Vehicle overload and dimensions increase the risk of accidents (Q10)	
	The presence of both active and passive safety features on vehicles improves traffic safety (Q11)	
<b>Driving Behavior and Habits</b>	Driving at speed high speed when the road is congested (Q12)	7,72%
	Drivers overtake the vehicle in front with too close a distance (Q13)	
	Motorists obstructing other drivers to precede (Q14)	
	Other drivers overtaking from the shoulder (Q15)	
<b>Vigilance and Concern about Traffic Conflicts</b>	The existence of Baitussalam Toll gate in Banda Aceh-Krueng Raya Road (Q1)	6,64%
	Heavy vehicle activity on Sibanceh Toll road construction (Q2)	
	Sibanceh Toll Road construction activities cause damage to Banda Aceh- Krueng Raya Road (Q3)	
	Operation of Baitussalam Toll Gate improves traffic safety (Q5)	
	There is an increase in traffic volume on the Banda Aceh-Krueng Raya Road after the Baitussalam toll gate operates (Q6)	
<b>Awareness Drive</b>	Angry at other drivers (Q20)	4,68%
	Parking the vehicle on the road cause of accident (Q16)	

## 4 Conclusion

From this safety study of Banda Aceh - Krueng Raya Road based on user perception, the following main conclusions were obtained. From the observation, there are several aspects that are not in accordance with safety technical standards, road surface markings are in bad condition, traffic signs are not visible, and the lack of street lights. There is an increase in traffic volume after the Baitussalam Toll Gate starts to operate on the Banda Aceh - Krueng Raya Road section. Of the 290 respondents, the variable with the highest average value was variable Q21 with an average value of 3.70, the variable with the lowest average value was variable Q13 with an average value of 1.38. The results of factor analysis shows that the occurrence of accidents due to using cellphones while driving increases the risk of accidents by 0.799, overtaking the vehicle in front with a close distance variable weight of 0.786 and enforcing vehicle speed restrictions with a variable weight of 0.759. Factors influencing public perceptions of motorists on road safety traveling of Banda Aceh-Krueng Raya Road, namely driving skills and driving behavior by 23.32%, potential damage and maintenance of road facilities by 13.15%, driving behavior and habits by 7.72%, vigilance and concern about traffic conflicts by 6.64%, and finally driving awareness by 4.68%.

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