



(MUDIMA)



Analysis and Solution of Traffic Congestion on Audian Road Section in Dili City

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ARTICLE INFO

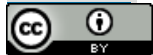
Keywords: Traffic Volume, Road

Received : 4 August

Revised : 24 September

Accepted : 25 October

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ABSTRACT

Traffic congestion caused by traffic volume close to road capacity, where the service level can be seen from the degree of saturation, ie $DS = V / C$. Ideally the value of $V / C = 0,82$. From visual observations, in Palu has frequent traffic congestion especially at peak hours on a particular road segment. One reason is the high vehicle growth is not matched by growth in road infrastructure. The purpose of this paper is to evaluate the performance of the street between two signalized intersections in the city of Dili to determine the causes and find solutions solving traffic congestion. The survey will be conducted to obtain primary data and secondary data analysis required in the performance of such road traffic data, data geometric road side barriers, interviews with passengers and motorists. The study was conducted for 3 days at 06:00 to 22:00 with the assumption that the traffic data coverage is 93%. This paper recommends a treatment that is optimized bersinyal roads by managing the intersections along the road segment between intersections with traffic cut off by installing a signal light and each intersection there is an alternative to motorists to avoid congestion, after allowing back off to prevent the flow of traffic queues length

INTRODUCTION

Transportation is the activity of moving goods or passengers from one place to another safely. Transportation is fundamental to economic development, community development, and industrial growth. Therefore, a dense population inevitably leads to traffic flow, which is the number of vehicles using the roads, influenced by developments in the area, as everyone needs transportation for school, work, and so on. Traffic flow is the number of motor vehicles passing through a point on the road per unit of time, expressed in vehicles/hour, motorcycles/hour, or annual average daily traffic (AADT) (Siby et al., 2024).

Traffic problems that cause congestion often occur around public facilities, such as schools, markets, terminals, and others. Many vehicles stop on the side of the road near these public facilities, entering and exiting a certain place. Traffic congestion often occurs in urban areas as a result of people's activities, such as traveling from home to work, school, or other activities (Castro, 2014). Traffic congestion is particularly noticeable during rush hours, both in the morning and afternoon, namely during work hours, school hours, or other activities, as well as in the afternoon when people are returning home from work, school, or other activities. The problem that often occurs in the Audian sub-district of Dili city is due to several

factors, including the high growth in the number of private vehicles.

Traffic conditions on roads in the city of Dili are very congested due to increased activity in education, trade, transportation, services, shops, and other activities, which has had an impact on the increase in community activity (Kumita et al., 2022). Educational centers are one of the places prone to traffic jams because schools in the city of Dili are mostly located on the side of the road. Activities in front of these shops and clinics directly affect traffic conditions on the surrounding road network. Audian Road is one of the roads in Dili city with various traffic problems such as congestion. This road functions as a national road, which is an arterial road connecting provincial capitals. Various types of activities on the Audian Road section, including clinics and shops, will result in traffic problems. This is due to the movement of vehicles entering and exiting, parked vehicles, and pedestrians going to and from shops. This condition tends to cause movement, which will ultimately lead to transportation problems such as decreased road performance, traffic conflicts, and increased delays. This indication is evident on several road sections in Dili City, such as on Dili Audian Road, as shown in the following image.



Figure 1. Condition of Audian Road in front of the Supermarket

The current performance of the Audian Road section (in front of the supermarket) is that there are delays caused by vehicles entering and exiting the supermarket, resulting in traffic congestion in front of the supermarket. The supermarket is located at Audian Road No. 282, Bemori, Santa Cruz Utara District, Dili City. The presence of the supermarket on Audian Road generates traffic flow in the area

around the supermarket. Additionally, there are several other locations near the supermarket that have the potential to generate traffic, including a mini-market, a used car dealership, a cosmetics store, a clinic, and residential areas. The movement of people and goods in the area is very high, making Audian Street a busy route around the supermarket on weekdays from 6:45 AM to 7:45 AM, 12:15 PM

to 1:15 PM, and 2:15 PM to 3:15 PM, based on field surveys. This study aims to analyze and evaluate the performance of the road between two signalized intersections in the city of Dili so that the causes of traffic congestion can be identified and solutions found.

METHODS

Data Collection Methods

The data used in this study consists of two types of data, namely primary data and secondary data.

1. Observation

The primary data obtained is as follows:

- a. Road section geometric data
- b. Side obstacle data
- c. Traffic volume data

2. Documentation

The secondary data obtained is as follows:

a. Population data

Survey Method

A survey is a method of collecting primary data through direct recording in the field. The method used in this survey is to take direct measurements using a tape measure, namely the number and width of traffic lanes, medians, shoulders, and sidewalks.

Survey steps:

1. Prepare survey tools such as a tape measure/measuring tape and writing instruments and 1 person in charge of recording and documentation.
2. Record the measurement result on the prepared form

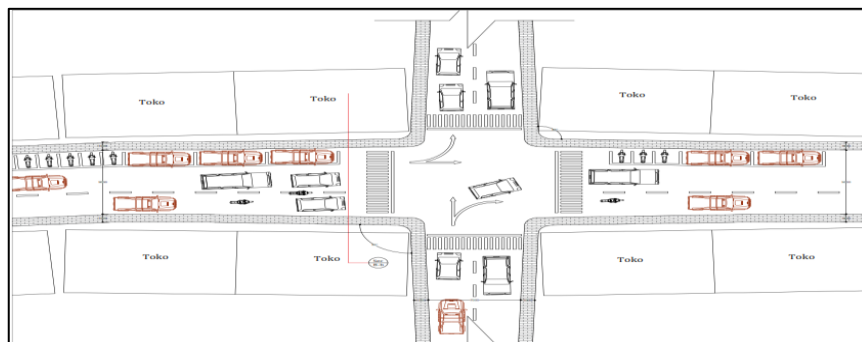


Figure 2. Geometric Inventory Measurement

Side Obstacle Survey

Side Obstacle Survey The side obstacle survey recorded the number of side obstacles that occurred in front of the supermarket. In conducting the survey, the surveyors were equipped with watches (time measuring devices), survey forms, writing instruments, and work boards. The supermarket is located on Audian Road, Dili City. This study aims to obtain the number of side obstacle incidents on the road in front of the Dili City Supermarket. The Side Obstacle Survey was conducted over 3 days, namely Monday, Tuesday, and Wednesday, during working/school hours. The survey was conducted from 06:30 to 10:00 WITA and 11:00 to 14:15 WITA when the Supermarket was open for business. From 10:00 AM to 11:00 AM WITA, the survey results from the previous hour were recorded, and the surveyors took a lunch break. The survey method

involved manual recording for 15 minutes per session and was conducted by two surveyors on each side of the road.

Data Processing and Analysis

This analysis uses a conventional calculation method, which is to calculate the volume of circulating vehicles.

1. Road Section Performance Analysis

Several indicators used in analyzing road section performance are as follows:

a. Capacity

From the geometric data obtained from the survey, the road section capacity is determined by entering certain variables based on the existing geometric data in the formula according to the Indonesian Road Capacity Guidelines (PKJI, 2014).

b. Degree of Saturation $D_j = Q/C$

This variable is used to determine whether a road section has a capacity problem or not. Factors that influence the degree of saturation are capacity and traffic volume.

c. Speed C

The speed used in this study is the average speed in the area, so the travel time obtained from the survey results is required. The average travel time data is calculated for each desired time interval and entered into the formula to obtain the average vehicle speed for each desired time interval. The presence of clinics and supermarkets will generate trips. Since the supermarket is not operating, the traffic volume obtained from the survey results is reduced by the existing generation. In this study, school activities are assumed to be the most decisive factor in determining the side obstacle class, while other factors such as shops and housing, which ideally also have an influence, are assumed to have a small influence. In calculating road performance, in this case, what changes are traffic

volume and the side obstacle class. Thus, by including these factors, the capacity, degree of saturation, and level of service of the road can be obtained.

RESULTS AND DISCUSSION

Data Analysis

Traffic Volume Data Analysis (Q)

From the results of the traffic volume survey data collection, the peak hours will then be determined based on the largest volume during the data collection period in units of vehicles per hour (veh./hour), then the units will be converted again from vehicles per hour (veh./ h) to passenger car equivalent per hour (pce/h) by multiplying it by the passenger car equivalent (pce), except for non-motorized vehicle (NMV) data, as this data is considered separate from the side obstacle adjustment factor in accordance with the road section calculation procedures established by both methods.

Volume during peak hours in 3 segments:

1. Monday, July 15 2024



Figure 3. Traffic from 10:00 to 11:00

Based on Figure 3, it can be seen that peak traffic occurs between 10:00 and 11:00 a.m. toward the shops = 868 vehicles per hour and

toward the city center = 928 vehicles per hour, with a total of 1,797 vehicles per hour in both directions.

2. Tuesday, July 16 2024



Figure 4. Traffic at 4:00 p.m. - 5:00 p.m

Based on Figure 4, it can be seen that peak traffic occurs between 16:00 and 17:00, with traffic heading towards the supermarket at 939 vehicles per hour and traffic heading towards the

city center at 954 vehicles per hour, for a total of 1,893 vehicles per hour in both directions.

3. Wednesday, July 17 2024



Figure 5. Traffic from 4:30 p.m. to 5:30 p.m

Based on Figure 5, it can be seen that peak traffic occurs between 16:30 and 17:30, with traffic heading towards the clinic at 1038 vehicles

per hour and traffic heading towards the city center at 1057 vehicles per hour, for a total of 2095 vehicles per hour across two lanes.

Side Barrier Analysis

Table 1. Side Barriers

Day	Hour	Pedestrians (OK)	Stopped Vehicles (KP)	Entering Vehicles (MK)	Moving Vehicles (KL)
Monday	6:00-17:00	338	155	89	219
Tuesday	7:00-17:00	362	158	129	160
Wednesday	7:00-17:00	309	218	112	190

Source: Research Data (2024)

Free Flow Speed

The following is road condition data on the Audian Road section in front of the supermarket during sales activities in accordance with the free flow speed adjustment factor.

1. Light Vehicle Free Flow Adjustment Factor (FVO)

The basic free flow adjustment factor for light vehicles (FVO) is determined based on the type of road and vehicle. The Audian Road section is classified as a two-lane undivided road (2/2 UD) and the vehicle type is light vehicles.

2. Traffic Lane Width Adjustment Factor (FVW)

The traffic lane width adjustment factor (FVW) is determined based on the effective traffic lane width. The Audian road section is classified as a two-lane undivided road (2/2 UD), and the effective traffic lane width when there are parked cars on the side of the road is 7 meters.

3. Side Obstacle Free Flow Adjustment Factor (FFVSF)

The Free Flow Adjustment Factor due to Side Obstacles (FFVSF) is determined based on the road type, side obstacle class, and effective shoulder width. Based on the conditions on the Audian road section, it is classified as a two-lane undivided road (2/2 UD). Based on the research results, the side obstacle class when the

supermarket is operating is classified as VL (Very High). The width of the barrier is 1 meter.

4. City Size Adjustment Factor (FFVCS)

The city size adjustment factor (FFVCS) is determined based on the population (in millions) of a city or region.

Based on data from the Central Statistics Agency (BPS), the population of Dili City is 277,279 people. The adjustment factor for city size is in the range of 0.5–1.0 million people, so the FFVCS value is 0.95. Therefore, the free flow speed in front of the supermarket during school hours is:

1. Calculation of free flow speed on Tuesday

$$FV = (FV_0 + FV_w) \times FFV_{SF} \times FFV_{CS}$$

$$FV = (44 + 3) \times 0,72 \times 0,95$$

$$FV = 32,15 \text{ km/h}$$

2. Calculation of free stream velocity, on Wednesday

$$FV = (FV_0 + FV_w) \times FFV_{SF} \times FFV_{CS}$$

$$FV = (44 + 3) \times 0,72 \times 0,95$$

$$FV = 32,15 \text{ km/h}$$

3. Calculation of free stream velocity, on Thursday

$$FV = (FV_0 + FV_w) \times FFV_{SF} \times FFV_{CS}$$

$$FV = (44 + 3) \times 0,82 \times 0,95$$

$$FV = 36,61 \text{ km/h}$$

Table 2. Results of Free Stream Velocity Calculations During School Activities

Day	Free Stream Velocity	Adjustment Factor				FV
		FV _o	FV _w	FFV _{SF}	FFV _{CS}	
Monday	At present	44	3	0,81	0,95	32,15 km/h
Tuesday	At present	44	3	0,81	0,95	32,15 km/h
Wednesday	At present	44	3	0,81	0,95	36,61 km/h

Source: Analysis Results

Road Capacity Analysis (C)

Statistics (BPS) for the city of Dili is 277,279 people, the adjustment factor for city size is in the range of 0.5 – 1.0 million inhabitants, so the value of FCCS = 0.94

Therefore, the road capacity in front of the supermarket during school hours is:

1. Road capacity on Monday

$$C = CO \times FCW \times FCSP \times FCSF \times FCCS$$

$$C = 2900 \times 1,14 \times 0,94 \times 0,72 \times 0,94$$

$$C = 2103,25 \text{ smp/h}$$

2. Calculation of road capacity on Tuesday

$$C = CO \times FCW \times FCSP \times FCSF \times FCCS$$

$$C = 2900 \times 1,14 \times 0,94 \times 0,72 \times 0,94$$

$$C = 2103,25 \text{ smp/h}$$

3. Calculation of road capacity on Wednesday

$$C = CO \times FCW \times FCSP \times FCSF \times FCCS$$

$$C = 2900 \times 1,14 \times 0,94 \times 0,81 \times 0,94$$

$$C = 2366,16 \text{ smp/h}$$

From the above calculations, the road capacity was obtained. Audian in front of the supermarket during sales activities was 2103.25 vehicles per hour on Monday, 2103.25 vehicles per hour on Tuesday, and 2366.16 vehicles per hour on Wednesday.

Saturation Degree Data (Dj)

1. For the morning rush hour

$$D_j = Q/C$$

$$D_j = \frac{2.055}{2.486}$$

$$D_j = 0,82 \text{ smp/h}$$

2. For the midday rush hour

$$D_j = Q/C$$

$$D_j = \frac{2.018}{2.486}$$

$$D_j = 0,81 \text{ smp/h}$$

3. For the afternoon rush hour

$$D_j = Q/C$$

$$D_j = \frac{2.041}{2.486}$$

$$D_j = 0,82 \text{ smp/h}$$

The calculation results show that the highest degree of saturation occurred on Monday afternoon at 0.82 smp/hour.

Delay

The delay is determined using the equation below, where the intersection delay must first be calculated.

$$T = TLL + TG$$

1. Average Traffic Delay (TLL)

TLL for a 3-way intersection can be calculated using the following equation:

$$TLL = \frac{1,0504}{(0,2742 - 0,2042 D_j)} - (1 - D_j)^2$$

$$TLL = \frac{1,0504}{0,2742 - 0,2042 \times 0,82} - (1 - 0,82)^2$$

$$TLL = 9,839 \text{ Seconds/smp}$$

2. Major Road Traffic Delay (TLLMa)

$$TLLMa = \frac{1,0504}{0,2742 - 0,2042 D_j} - (1 - D_j)^{18}$$

$$TLLMa = \frac{1,0504}{0,2742 - 0,2042 \times 0,82} - (1 - 0,82)^{18}$$

$$TLLMa = 7,279 \text{ Seconds/smp}$$

3. Minor Traffic Delay (TLLMi)

$$TLLMi = \frac{Q_{kb} \times TLL \times Q_{ma} \times TLLma}{Q_{mi}}$$

$$TLLMi = \frac{536,2 \times 9,839 - 475,5 \times 7,279}{377,7}$$

$$TLLMi = 4,765 \text{ second/smp}$$

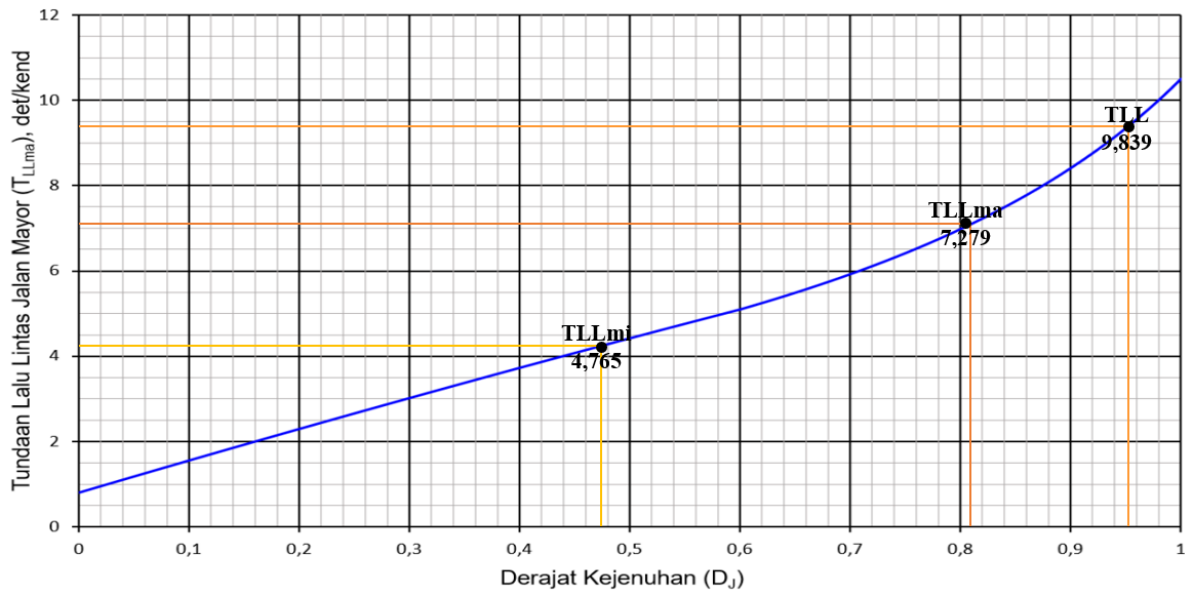


Figure 6. Degree of Saturation (Dj)

Queue Probability (PA)

Queue probability is expressed as a percentage (%). Queue probability is determined by finding the upper and lower limits using the following equation:

Upper Limit PA: $47,71 D_j - 24,68 D_j^2 + 56,47 D_j^3$

Lower Limit PA: $9,02 D_j + 20,66 D_j^2 + 10,49 D_j^3$

Upper Limit PA = $47,71 * 0,82 - 24,68 * 0,82 + 56,47 * 0,82$

Upper Limit PA = 66,83%

Lower Limit PA = $9,02 * 0,82 + 20,66 * 0,82 + 10,49 * 0,82$

Lower Limit PA = 24,3376%

Thus, the probability of queuing at this intersection is between 24,3376% - 66,83%

Intersection Performance When There is Parking

Intersection performance analysis is divided into three parameters, namely intersection capacity, degree of saturation, delay, and queue probability.

1. Intersection Capacity

Intersection capacity is calculated using the following equation:

$$C = CO \times FLP \times FM \times FUK \times FHS \times FBKi \times FBKa \times FRmi \text{ (Smp /hour)}$$

2. Basic Capacity (Co)

Based on the Basic Capacity Table (C0), the intersection type that corresponds to the intersection under review is intersection type 322 with a C0 value of 2900 vehicles/hour.

3. Determination of Average Approach Width (LRP)

The average approach width (LRP) is calculated by first calculating the width of the major and minor road approaches.

North = A: 4,5 m

West = B: 4 m

South = C: 5 m

$$LRP = (A/2)$$

$$LRP = (B+C/2)2$$

$$LRP BC = (4+5/2)/2$$

$$LRP BC = (4+2,5)/2$$

$$LRP BC = 3,25$$

DISCUSSION RESULTS

Solutions

The best solution in this study requires alternative solutions to create solutions that ensure safe and efficient traffic conditions for road users. Therefore, we request that the government observe parking on Audian Road and only allow parking per minute. An alternative that can be used is traffic simulation used for systems such as the city center network system, highway intersections, and other traffic systems. The application of computer software can be more useful for traffic planning and traffic system operation. One computer software that can be used to perform traffic simulations is software. Solutions to the evaluation results of the Audian road section, several steps that can be taken

based on the analysis that has been carried out are as follows:

1. Traffic Management

Parking Arrangement: Reduce parking on the road that causes congestion. This can be done by providing separate parking areas or implementing a pay-per-minute parking system to regulate the number of vehicles parked on the side of the road.

Implementation of a One-Way System: If possible, implement a one-way system on congested road sections to reduce traffic conflicts and improve the flow of vehicles.

2. Infrastructure Improvement

Road Geometric Improvements: Improving road geometry, such as lane width and curve radius, to increase road capacity and safety.

Construction of Special Lanes: Providing special lanes for public transportation and bicycles, which can reduce private vehicle traffic congestion.

3. Use of Technology Systems

Intelligent Traffic Management System: Implementing technologies such as traffic lights that can be adjusted based on traffic volume to reduce congestion during rush hour.

Traffic Information Applications: Developing applications that provide real-time information about traffic conditions and alternative routes to road users.

4. Public Education and Awareness

Awareness Campaigns: Conducting campaigns to raise public awareness about the importance of obeying traffic rules and reducing the use of private vehicles, especially during rush hour.

CONCLUSION

The factors that influence the performance of this intersection are geometric conditions, environmental conditions, traffic volume, traffic flow, intersection capacity, degree of saturation, queue length, and delay. Therefore, high traffic volume and low intersection capacity will affect the degree of saturation (DJ) value of $0.82 < 0.85$. From the results of the intersection performance analysis when there is parking, the saturation degree (DJ) value obtained is $0.82 < 0.85$ with traffic delay (TLL) of 9.839 Smp/second, and for the queue probability (PA) for the lower limit of 24.3376% and the upper limit of 66.83%.

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