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Enhancing Traffic Flow and Safety at LMU Nurtanio Road Crossings - Abdul Rahman Saleh Intersection in Bandung

An An Anisarida [a*] and Irvan Budi Wicaksono [a]

[a] Department of Civil Engineering, Winaya Mukti University, Indonesia.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Bandung is the largest metropolitan city in West Java Province and serves as its provincial capital. One of the locations where vehicle queues or traffic congestion occurs is at the level crossings between the highway and railway tracks, including the direct crossing (JPL) at Andir on LMU Nurtanio Street - Abdul Rahman Saleh Street. The purpose of this research is to assess the performance of the existing road section, simulate it using the PTV VISSIM program, and find alternative solutions to the identified problems. In this study, primary data was obtained through direct field measurements, including vehicle volume, queue length, and road geometry data. Additionally, secondary data on the number of trains passing through the crossing was obtained from PT Kereta Indonesian Fire. The PTV VISSIM program used in this analysis is a student-licensed program, which implies limitations and simplifications in the analysis. The performance calculation of the road section yielded a degree of saturation (Ds) value of 0.73 for LMU Nurtanio Street and 0.77 for Abdul Rahman Saleh Street. According to the road service levels set by the government, both roads fall below service level C. The PTV VISSIM modeling results indicated a queue length of 66.59 m for LMU Nurtanio Street and 105.18 m for Abdul Rahman Saleh Street. Bandung study uses PTV VISSIM to assess LMU Nurtanio - Abdul Rahman Saleh Streets, revealing congestion issues. Queue lengths highlight improvement needs.

**Corresponding author: Email: aanisarida@gmail.com, anisarida69@gmail.com;*

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1. INTRODUCTION

One of the causes of traffic jams in Bandung City is road capacity. Road capacity is the ability of a road section to accommodate the flow or volume of traffic in a certain unit of time, expressed in terms of the number of vehicles that pass through that section of road in one hour (vehicles/hour), or by considering the various types of vehicles that pass through the road section using passenger car units. as a vehicle unit in capacity calculations, so that capacity uses passenger car units per hour or (pcu)/hour. Congestion occurs due to traffic flow that exceeds the capacity of the road section. This happens a lot on the streets of Bandung City. In the realm of transportation studies, addressing common issues holds paramount significance. The challenges often faced in scientific communities, such as traffic congestion and safety concerns, necessitate thorough investigation. This research focuses on the LMU Nurtanio Road Crossings - Abdul Rahman Saleh Intersection in Bandung as a case study, presenting an opportunity to delve into practical solutions. By examining the intersection, we aim to contribute insights that extend beyond localized concerns, offering valuable perspectives for the broader scientific community grappling with traffic management and safety.

One of the locations where vehicle queues or traffic jams occur is access at level crossings between highways and railway lines. This queue generally occurs because vehicles are waiting to be able to cross the level crossing. According to Public Relations of the Edan Sepur Bandung Region, this increase in violations occurred at 4 Level Crossings with the First Rank at JPL Andir increasing 36.2%, followed by JPL Laswi increasing 35.2%, then JPL Kiaracondong increasing 20%, and JPL Cikudapateuh increasing 12.6% . Only JPL Cimindi experienced a decline of 20.8%. (Abdullah Putra Gandhara, 2022).

This study specifically evaluates the performance of the road section located at the intersection between LMU Nurtanio Street and Abdul Rahman Saleh Street in Bandung, where a railway track is present. PTV VISSIM is employed as an effective simulation tool to analyze traffic flow at this intersection, providing a clear picture of how vehicles move and interact in the area. With a focus on identifying vehicle queues and traffic congestion issues, the primary aim of this research is to find alternative solutions. Based on simulation results, suggested road performance improvements include road design modifications, adjustments to traffic signals, and other measures aimed at enhancing intersection performance and reducing vehicle queues. Furthermore, the model provides recommendations to optimize traffic flow at the intersection, aiming to achieve service levels in line with government standards. Improvements in road user safety are also proposed through changes in road design and traffic control at the intersection. The findings of this research are not only applicable to Bandung but can serve as a guide for other cities facing similar challenges in managing traffic at intersections between roads and railway tracks. The information generated by this model can also offer significant benefits to the Bandung city government and PT Indonesian Fire Railway, assisting them in making better decisions regarding traffic improvement and management in the region.

Bandung City is one of the largest metropolitan cities in West Java Province, and is the capital of the province. Population growth in a city can be one of the causes of the increase in the number of vehicles in that city. The population of Bandung City in 2021 based on the results of the 2021 Population Census is 2,464,160 people, with a population growth rate in Bandung City in 2010 – 2021 of 0.21% [1]. Population growth has resulted in an increase in transportation activities using motorized vehicles in the city of Bandung. The number of vehicles is too large and cannot be accommodated by existing roads, causing vehicle queues or traffic jams. One of the locations where vehicle queues or traffic jams occur is access at level crossings between highways and railway lines [2-5]. This queue generally occurs because vehicles are waiting to be able to cross the level crossing. According to Public Relations of the Edan Sepur Bandung Region, this increase in violations occurred at 4 Level Crossings with the First Rank at JPL Andir increasing 36.2%, followed by JPL Laswi increasing 35.2%, then JPL Kiaracondong increasing 20%, and JPL Cikudapateuh increasing 12.6% . Only JPL Cimindi experienced a decline of 20.8%. (Abdullah Putra Gandhara, 2022)Based on this data, the level crossing on Jalan LMU Nurtanio - Jalan Abdul Rahman Saleh is ranked first for traffic violations.

Long queues of vehicles, long travel delays, and Congestion causes travel time to increase. To improve services at level crossings, it is necessary to evaluate, analyze and also model level crossings on Jalan LMU Nurtanio - Jalan Abdul Rahman Saleh using the PTV VISSIM program . PTV VISSIM is a type of software for microscopic traffic modeling, the PTV VISSIM program can make it easier to analyze traffic as a whole because it can provide an overview of field conditions in the form of 2D and 3D simulations.

2. THEORETICAL REVIEW

2.1 Road

Roads in urban areas have permanent development and continuous along the entire road, minimum on one side of the road, whether in the form of land development . Roads in urban centers with a population of more than 100,000 people are always classified in this group, roads in urban areas with a population of less than 100,000 people are also classified in this group . (PKJI, 2023).

2.2 Grouping Roads According to Function

Public roads according to their function are based on (Law No. 38 of 2004) in Article 8 concerning arterial roads, collector roads, local roads and environmental roads [6-10].

a. Arterial roads are public roads that function to serve the main transportation with the characteristics of long distance travel, high average speeds, and the number of access roads is limited in an efficient manner.
b. Collector roads are public roads that function to serve collector or divider transportation with the characteristics of medium distance travel, moderate average speed, and a limited number of access roads.
c. Local roads are public roads that function to serve local transportation with the characteristics of short distance travel, low average speed, and an unlimited number of entrances.
d. Environmental roads are public roads that function to serve environmental transportation with the characteristics of short distance travel and low average speeds.

2.3 Road Grouping According to Class

Based on class, roads are divided into several class groups, namely:

a. Class I roads, namely arterial roads that can be passed by motorized vehicles, including loads with a width not exceeding 2,500 millimeters, a length not exceeding 18,000 millimeters and, the heaviest axle load permitted is greater than 10 tons;
b. Class II roads, namely arterial roads that can be passed by motorized vehicles, including loads with a width not exceeding 2,500 millimeters, a length not exceeding 18,000 millimeters and, the heaviest axle load permitted is greater than 10 tons;
c. Class III A roads, namely arterial or collector roads that can be passed by motorized vehicles, including loads with a width not exceeding 2,500 millimeters, a length not exceeding 18,000 millimeters and the heaviest axle load on permitted vehicles greater than 8 tonnes;
d. Class III B roads, namely collector roads that can be passed by motorized vehicles, including loads with a width not exceeding 2,500 millimeters, a length not exceeding 12,000 millimeters and the heaviest axle load permitted for vehicles greater than 8 tons;
e. Class III C roads, namely local arterial roads that can be passed by motorized vehicles, including loads with a width not exceeding 2,100 millimeters, a length not exceeding 9,000 millimeters and the heaviest axle load permitted greater than 8 tons;

2.4 Road Grouping Based on Status

Road grouping is used to create legal certainty for road management , in accordance with the authority of the government and regional governments. Roads according to their status in Law Number 38 of 2004 are grouped into national roads, provincial roads, district roads, city roads and village roads.

a. National roads are arterial roads and collector roads in the primary road network system that connects provincial capitals, national strategic roads and toll roads.
b. Provincial roads are collector roads in the primary road network system that connect the provincial capital with the district/city

capital, or between district/city capitals, and provincial strategic roads.

c. Regency roads are local roads in the primary road network system which does not include roads connecting the district capital with the sub-district capital, between sub-district capitals, district capitals and local activity centers, between local activity centers in the region, as well as roads in the secondary road network system within the region [11-16].
d. City roads are public roads in the secondary road network system that connect service centers within the city, connect service centers with parcels, connect between parcels, and connect residential centers within the city.
e. Village roads are public roads that connect areas or between settlements within villages, as well as environmental roads.

2.5 Traffic Performance

Road performance is a quantitative measurement that describes certain conditions that occur on a road section. The performance of a road can be defined as the extent to which a road is able to carry out its function, where according to PKJI 2023 what is used as an assessment parameter is the Degree of Saturation (DS) . The 2023 Road Capacity Guidelines explain that the level of road service can also be calculated based on the VCR (*Volume Capacity Ratio)* scope limits on the road section. In assessing a road's performance, it can be viewed from capacity, degree of saturation, average speed, travel time, length of delay and length of queue with a study of the performance of the road section.

Based on the Ministerial Regulation on road service levels, the relationship between service level, speed and degree of saturation is described as in the Table 1.

2.6 Traffic Volume

Volume is a parameter of the amount of traffic flow. Traffic volume describes the number of vehicles passing one observation point in a unit of time. High traffic volumes require larger road widths, thereby creating safety and comfort.

Average Daily Traffic (LHRT) is the average traffic volume in a unit of time. Average Daily Traffic is divided into 2 types based on how the data is obtained, namely: Average Daily Traffic (LHR) and Average Annual Daily Traffic (LHRT). LHR is calculated using the following equation.

$$LHR = \frac{Jumlah\ lalu\ lintas\ selama\ pengamatan}{Lamanya\ Pengamatan} \text{.............} \ (1)$$

2.7 Road Capacity

There are several capacity benchmarks that are often used, namely basic road capacity and road operational capacity, where road operational capacity is the basic capacity of a road section that has been adjusted by various environmental factors. Several different concepts are used to define the motor vehicle traffic capacity that a road or intersection will or should accommodate.

Road capacity is expressed in units of passenger cars per unit of observation time, normally (pcu/hour), with the basic equation for determining road operational capacity as follows.

$$C = Co \times FC_{LJ} \times FC_{PA} \times FC_{HS} \times FC_{UK} \quad (2)$$

Where :

C = operational capacity (pcu/hour)
Co = basic capacity (pcu/hour)
FC_{LJ} = road width adjustment factor
FC_{PA} =direction separation adjustment factor (only for undivided roads)
FC_{HS} = adjustment factor for side and shoulder obstacles
FC_{UK} = city size adjustment factor

2.8 Speed

Speed is one of the general parameters in stating the level of service of a road or *Level of Service* (LOS). In more general circumstances, LOS depends on a combination of speed or travel time, waiting time, fare, etc. Speed is the movement of a vehicle on a road section within a certain time period, in units of km/hour or m/second. This speed can be influenced by geometric characteristics, traffic conditions, time, place, environment and driver habits [17-20].

2.9 Free Flow Speed

Free flow speed or FV can be interpreted as speed at zero flow level, namely the speed that a driver would use if driving a motorized vehicle without other motorized vehicles on the road . The determination equation is as follows

$$FV = (FV0 + FVW) \times FFVSF \times FFVCS \ \ldots \ (3)$$

Where:

FV : Free flow speed of light vehicles in field conditions (km/hour)
FV0 : Basic free flow speed of light vehicles on the observed road
FVW : Speed adjustment for road width (km/hour)
FFVSF: Adjustment factor for side resistance and shoulder width or barrier distance
FFVCS : Adjustment factor for city size

2.10 Queue Length

Queue length is the length of the vehicle queue at an approach leg (meters) (*MKJI 1997*, n.d.)while the queue itself can be defined as the number of vehicles queuing at an approach (vehicles, smp) (*PKJI 2023*, n.d.). Or it can be simplified to the number of vehicles approaching an intersection mouth, measured from the stop line at the intersection mouth to to the end of the queue which can be measured in vehicle units or length units (meters).

Table 1Service level road

Service Level _	Related Operational Characteristics	V/C
A	Free flow, average travel speed > 80 km/hour, load factor at intersection = 0	≤ 0.6
B	Stable flow, average travel speed decreases to > 40 Km/hour, Load factor < 0.1	≤ 0.7
C	Stable flow, average travel speed decreases to > 30 Km/hour, Load factor < 0.3	≤ 0.8
D	Approaching unstable flow, average travel speed drops to > 25 km/hour, load factor < 0.7	≤ 0.9
E	Unstable flow, obstructed, with intolerable delays, average travel speed around 25 km/hour, volume at capacity, load factor at intersection < 1	≤1
F	Blocked flow, traffic jams, Average travel speed < 15 Km/hour, saturated intersection	>1

List 1. Kapasitas Dasar Jalan Perkotaan (Co)

Road Type	C_0 (AMP/hour)	Notes
4/2-T, 6/2-T, 8/2-T or One way	1700	Per lane (one way)
2/2-TT	2800	Per lane (2 ways)

Table 2. Capacity correction factors due to differences in Lane Width

Road Type	L_{LE} or L_{JE} (m)	FC_{LJ}
4/2-T, 6/2-T. 8/2-T or One way street	L_{LE} = 3.00	0.92
	3.25	0.96
	3.50	1.00
	3.75	1.04
	4.00	1.08
2/2-TT	L_{JE2way} = 5.00	0.56
	6.00	0.87
	7.00	1.00
	8.00	1.14
	9.00	1.25
	10.00	1.29
	11.00	1.34

Table 3. Capacity adjustment correction factors due to direction separation (FCPA)

SP Direction Separator %-%	50-50	55-45	60-40	65-35	70-30
Two Lanes 2/2	1.00	0.97	0.94	0.91	0.88
Four Lane 4/2	1.00	0.985	0.97	0.955	0.94

Table 4. Capacity adjustment factors for the effect of traffic lane width for Urban Roads with Shoulders (FCHS)

Type Road		Class Obstacle Side	HS side resistance and shoulder width			
			Effective shoulder width Ws			
			≤ 0.5	1.0	1.5	≥ 2.0
Divided Path	4/2-T, 6/2-T. 8/2-T or One way street	SR	1.02	1.03	1.03	1.04
		R	0.98	1.00	1.02	1.03
		S	0.94	0.97	1.00	1.02
		Q	0.89	0.93	0.96	0.99
		ST	0.84	0.88	0.92	0.96
Undivided Path	2/2-TT	SR	1.00	1.01	1.01	1.01
		R	0.96	0.98	0.99	1.00
		S	0.90	0.93	0.96	0.99
		Q	0.82	0.86	0.90	0.95
		ST	0.73	0.79	0.85	0.91

Table 5. Capacity adjustment factors for the effect of traffic lane width for urban roads with Kereb (FCHS)

Type Road	Class Obstacle Side	Adjustment factors for side obstacles and carriage-obstacle distance			
		Distance of carriage to nearest barrier as far as LKP (m)			
		≤ 0.5	1.0	1.5	≥ 2.0
4/2- T	Very low	0.95	0.97	0.99	1.01
	Low	0.94	0.96	0.98	1.00
	Currently	0.91	0.93	0.95	0.98
	Tall	0.86	0.89	0.92	0.95
	Very high	0.81	0.85	0.88	0.92
2/2-TT Or One way street	Very low	0.93	0.95	0.97	0.99
	Low	0.90	0.92	0.95	0.97
	Currently	0.86	0.88	0.91	0.94
	Tall	0.78	0.81	0.84	0.88
	Very high	0.68	0.72	0.77	0.82

Table 6. Capacity adjustment factors for city size (FCUK) on Urban Roads

City Size (Million Souls)	City Class	City Category	Factor Correct City Size (FCUK)
<0.1	Very small	Small town	0.86
0.1-0.5	Small	Small town	0.90
0.5-1.0	Currently	Medium City	0.94
1.0-3.0	Big	Big city	1.00
>3.0	Very large	Metropolis _	1.04

2.11 Time Delay

Delay is the duration of the difference in travel time of a journey, from one starting point to the final point under free flow conditions and obstructed flow. Delay is a very influential variable in determining traffic quality. Delay is used as a reference to determine the level of congestion in a road traffic. The higher the delay duration value, the greater the level of congestion on that road section.

2.12 Travel time

Travel time is the time required for a vehicle to pass a road section of a certain length, including all travel obstacles (seconds/pcu)(*PKJI 2023*, n.d.)

Travel time calculations can provide information about travel speed, number of vehicles, location, duration, frequency, and reasons for delays in observed traffic flow. Delays themselves are grouped into two types of delays, namely:

1. Fixed Delay (*fixed delay*), caused by traffic signals.
2. Operational *delays* are caused by traffic movements, such as turning vehicles, entering and exiting, parking, crossing the road, heavy traffic volumes, insufficient road capacity, and traffic accidents.

2.13 Vehicle Characteristics

Vehicles are a means of traffic in land transportation modes which are the largest component that uses roads. Vehicles can be motorized vehicles and non-motorized vehicles *.* There are variations in size from small to large vehicles, as well as low to fast speeds, which can be seen in (Table 7).

Table 7. Passenger car unit values (SMP)

Transportation type	Passenger Car Unit Value
Vehicle Medium (K S)	1.3
Passenger Car (MP)	1.0
Motorcycle (SM)	0.5

2.14 Railway Crossing

A railway crossing is a junction between a railway line and a highway. Crossings can occur in rural or urban areas. Some types of crossings are level crossings and non-level crossings. Non-level crossings are crossings between railway lines and highways that are not on the same plane, there are *flyovers* or *underpasses* .

2.15 Level Crossing Construction

Train operators in Indonesia are organized by a single operator PT. Kereta Api Indonesia (Persero), with the increase in train travel users, PT. KAI (Persero) strives to improve safety, punctuality, ease of service and comfort. Disruption to the smooth transportation of passengers or goods greatly affects the operator's credibility.

2.16 VISSIM PTV Software

VISSIM PTV Program is a tool or traffic simulation software for the purposes of traffic engineering, transportation planning , calculating signal times, public transportation, and microscopic city planning which is translated visually and developed in 1992 by an IT company in Germany. (Siemens, 2012). VISSIM comes from the words *VerkehrStadten – Simulationsmodel* (in German) which means city traffic simulation model.

2.17 Modeling Stage

When carrying out a simulation using VISSIM, there are several parameters that need to be determined and entered, so that the simulation model can run. The parameters that need to be set to run the simulation model are as follows:

1. Input backgrounds

The background is used to make offline simulation easier by inputting a screenshot of the location map used. Location maps can be obtained from Google Earth or Google Maps . Create a background by activating the background tool and right clicking on the vissim screen .

2. Create a road network (links)

Creating a road network describes the road network according to the conditions in the field, by setting the width and number of existing lanes, then entering the background on the Vissim application work screen . The steps at this stage are:

a. Activate *tool links*
b. Right click on the vissim application work screen
c. Click *add new link*
d. Determine the number *of lanes*
e. Finished

3. Determine the type of vehicle

Determining the type of vehicle is carried out by determining the type of vehicle based on data on the grouping of vehicle types passing at the intersection, namely passenger cars (MP), medium vehicles (KS), motorbikes (SM), and non-motorized vehicles (UM). If the type of vehicle has been determined, the number is added according to the previously created code and given a name as needed, with the following steps:

a. *Distributions*
b. Click on *Database*
c. 2D/3D models

d. *Add* , add according to the type of vehicle that has been created
e. Adjust to vehicle type

4. Input vehicle speed

Vehicle speed can be determined when vehicle movement occurs which has been obtained from survey results.

5. Inputting vehicle composition

Inputting vehicle composition is the stage for entering vehicle composition based on the specified vehicle type. The number of existing vehicles of each vehicle type is input in the RelFlow column.

6. Determine travel routes (vehicle routes)

Determining the travel route functions to regulate the direction of movement of vehicles that will pass. Travel route settings can be made based on what happens in the field.

7. Enter the number of vehicles

Enter the number of vehicles by inputting the vehicle volume data that has been obtained from the survey results. The steps are as follows:

a. Activate *tools*
b. Enable *vehicle input*
c. Determine the number of vehicles

8. Set traffic signals

Regulating traffic signals aims to regulate vehicles passing on a U-turn section. Traffic signals can be controlled via signal control then select signal controllers. In the edit signal control menu, it is used to make traffic signal settings.

9. Signaling traffic
10. Run the simulation.
11. calibration

Calibration is carried out using the *trial and error method* , until results are close to the observation data. The driver parameter values can be changed according to the expected prevailing field conditions. Some parameters in the calibration process are as follows:

a. Desired position at free flow , namely the presence/position of the vehicle on the lane.
b. Overtake on the same lane, namely behavior in preparing.
c. Distance standing, namely the distance between the driver when stopping.
d. Distance driving , namely the distance between drivers side by side when walking .
e. Average standstill distance , which is the parameter that determines safe distance.
f. Additive part of safety distance , namely the parameters that determine safe distance.
g. Multiplicative part of safety , namely the parameters determining safe distance.

3. MTEHODS

3.1 Research Methods

Research methodology is the stages of activities carried out in carrying out analysis from the initial stages of research to the final stages of research, which will produce a proposal and conclusion. This research method is very important so that readers can understand in explaining and summarizing the object being written about and the flow of the research.

Next, a primary survey was carried out which included a geometric survey of road segments, a vehicle volume survey, a vehicle speed survey, as well as a queue length survey obtained from direct surveys in the field. Next, secondary data is collected, in the form of Google Maps or Google Earth maps and other data needed for data analysis.

The final stage is processing and analyzing the data using the MS program. Excel and modeling using the PTV VISSIM program at the level crossing Jalan LMU Nurtanio – Jalan Abdul Rahman Saleh, then calibrated and validated to produce road segment performance output . The following are the stages carried out in conducting research analysis (see in Fig. 1).

3.2 Location Study

In this research, the location that will be used as material for modeling analysis is the level crossing on Jalan Nurtanio - Jalan Abdul Rahman Saleh, Bandung City, West Java Province. Based on the Decree of the Governor of West Java No: 620/Kep.883-DBMTR/2022 concerning Road Sections in the Road Network. According to its function, Jalan LMU Nurtanio has section code number 22.10.10158, with a length of 0.392 km and is a Secondary Collector Road.

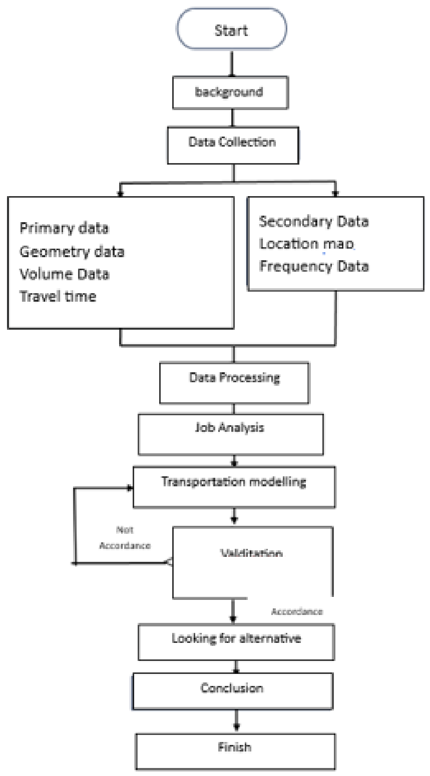

Fig. 1Flow diagram study

3.3 Data Collection

Primary data was obtained from direct observations carried out in the field, namely observing traffic volumes, queue lengths and side obstacles at crossings carried out over 7 days, using CCTV recordings as documentation. The secondary data used was obtained from PT. Kereta Api Indonesia (Persero), in the form of a train itinerary that crosses the level crossing on Jalan LMU Nurtanio - Jalan Abdul Rahman Saleh.

4. RESULTS AND DISCUSSION

Traffic volume observations are primary data obtained directly from observations in the field, which are differentiated according to direction. The total observation time was 7 x 24 hours using CCTV cameras, and manual recording was carried out. The direction of traffic movement is calculated according to the map image below.

Fig. 2. Distribution direction movement

4.1 Vehicle Volume Data

Based on table, obtained that the average vehicle volume daily (LHR) for Jalan LMU Nurtanio and Jalan Abdul Rahman Saleh is as following:

LHR Jalan LMU Nurtanio: 1,979 pcu / hour
LHR Jalan Abdul Rahman Saleh : 2,100 pcu/hour

4.2 Speed Data

From field observations, it was found that the average speed of vehicles on Jalan LMU Nurtanio was 20 km/hour for cars and 27 km/hour for motorbikes. Meanwhile, the average speed of vehicles on Jalan Abdul Rahman Saleh is 21.6 km/hour for cars, and 28.42 km/hour for motorbikes.

4.3 Queue Length

From the results of observations during a traffic survey, it was found that the maximum queue length for each road section (calculated from the back of the queue to the mouth of the crossing) was as follows.

4.4 Road Geometric Data

Geometry measurements are carried out by direct measurements in the field, using a push meter measuring instrument, the parameters measured are road width, crossing width, median and sidewalk width, the data obtained is as in the following Table 10.

4.5 Side Obstacle Data

From the results of observations in the field and adjusted to the PKJI 2023 Side Obstacle Class Table 11, this road is a commercial area, and there is high side road activity, it can be concluded that side obstacles are included in the high criteria.

4.6 Road Capacity Calculation

After determining the parameters, they are calculated using the road capacity formula for inner cities according to the 2023 Indonesian Road Capacity Guidelines.

1. **LMU nurtanio road capacity**

C = Co x FCW x FCSP x FCSF x FCCS
C = (1700*2) x 0.96 x 0.97 x 0.86 x 1
= 2722.82 pcu / hour
= 2723 pcu / hour

2. **Abdul Rahman Saleh Road Capacity**

C = Co x FCW x FCSP x FCSF x FCCS
C = (1700*2) x 1.08 x 0.97 x 0.86 x 1
= 3063.18 pcu / hour
= 3063 pcu / hour

From the results calculation obtained mark road capacity for Jalan LMU Nurtanio is 2723 pcu / hour, and Jalan Abdul Rahman Saleh is 3063 pcu / hour.

4.7 Calculation Degrees Saturation

Degrees saturation used For determine level performance something segment path, specified based on comparison between vehicle volumes with capacity road.

1. Degree of saturation on Jalan LMU Nurtanio

$$D_j = \frac{q}{C} = \frac{1979}{2723} = 0{,}73$$

2. Degree of saturation on Jalan Abdul Rahman Saleh

$$D_j = \frac{q}{C} = \frac{2100}{3063} = 0{,}69$$

From the calculation results, it was found that the degree of saturation value for the LMU Nurtanio road was 0.73 and the degree of saturation value for the Abdul Rahman Saleh road was 0.69.

4.8 Road Service Level

The road service level parameter is the comparison between vehicle volume and road capacity, this value can be equated with the value of the degree of saturation of the road, where the VCR (*Volume Capacity Ratio) comparison value for the LMU Nurtanio Road is 0.73 and the VCR (Volume Capacity Ratio)* comparison value has been obtained. *Ratio)* for Jalan Abdul Rahman Saleh is 0.69, this value is then matched with the road service level table in accordance with Minister of Transportation Regulation Number 14 of 2006, and the results are obtained according to the following Table 12.

Table 8. Mark junior high school vehicles from the direction of LMU Nurtanio - Abdul Rahman Saleh (South - North)

Route	Transportation type							Middle school average
	BC	junior high school	M.P	junior high school	K.S	junior high school	Total	
Day 1 (16.00 – 17.00)	2653	1061	799	799	25	33	1893	1979
Day 1 (17.00 – 18.00)	2758	1103	775	775	28	39	1917	
Day 2 (16.00 – 17.00)	2623	1049	987	987	33	43	2079	
Day 2 (17.00 – 18.00)	2622	1049	952	952	19	25	2026	

Table 9. Mark junior high school Vehicle from Direction Abdul Rahman Saleh - LMU Nurtanio (North - South)

Route	Transportation type							Middle school average
	BC	junior high school	M.P	junior high school	K.S	junior high school	Total	
Day 1 (16.00 – 17.00)	2417	967	1013	1013	31	40	2020	2100
Day 1 (17.00 – 18.00)	2553	1021	963	963	29	38	2022	
Day 2 (16.00 – 17.00)	2894	1158	968	968	29	38	2164	
Day 2 (17.00 – 18.00)	2751	1100	1044	1044	39	51	2195	

Table 10. Vehicle queue lengths at crossings

Roads	Queue Length
Jalan Abdul Rahman Saleh	260 m
Jalan LMU Nurtanio	210 m
North Maleber Street	38 m

Table 11. Geometric data road

Parameter	LMU Nurtanio (m)	Abdul Rahman Saleh (m)	North Maleber (m)
The width of the road	16	16	5.3
Median Width	0.5	0.5	-
Crossing Width	11	11	-
Road Shoulder Width	0.5	0.5	-
Sidewalk Width	4	1	-
Median Length	90	150	-

Table 12. Levels of service road

Roads	V/C value	Service Level
LMU Nurtanio	0.73	C
Abdul Rahman Saleh	0.69	B

Table 13. Comparison long queue

Roads	Field Survey	PTV VISSIM Results	Percentage	Accuracy
LMU Nurtanio	210 m	207.67 m	98.89%	98.55%
Abdul Rahman Saleh	260 m	252.39 m	97.07 %	
North Maleber	38 m	37.89 m	99.71	

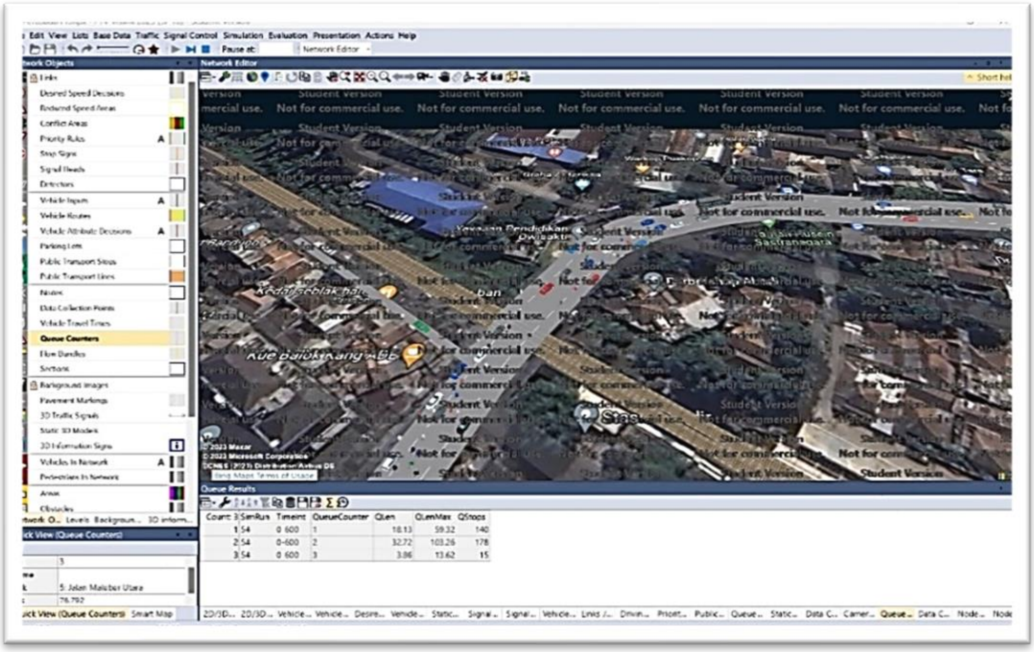

Fig. 3. Modeling results with the PTV VISSIM program

Queue Results

Count: 3	SimRun	TimeInt	QueueCounter	QLen	QLenMax	QStops
1	76	0-600	1	152.46	252.39	2321
2	76	0-600	2	144.91	207.67	1731
3	76	0-600	3	13.74	37.89	91

Fig. 4. Queue length data for the PTV VISSIM program

4.9 Modeling with the PTV VISSIM Program

Based on the data above, data input is then carried out in the program with the following stages:

1. Opens the PTV VISSIM program
2. Enter the background (*Background)* and set the scale
3. Create a network of roads (links *)* and *connectors*
4. Enter the vehicle type
5. Enter the travel route
6. Set vehicle speed
7. Set the composition of the vehicle
8. Regulate driving habits (*vehicle behavior*)
9. Set the priority path
10. Run the simulation
11. View simulation results data

4.10 Comparing PTV VISSIM Program Results and Field Data

From the simulation results, we can get the queue length (*queue data*), and we compare the queue length results in the simulation with the queue length from the survey results in the field.

5. CONCLUSION

From the results of field observations, analysis calculations and modeling using the PTV VISSIM Program, it can be concluded:

1. Based on the results of field surveys, and calculating road capacity in accordance with the 2023 Indonesian Road Capacity Guidelines, the saturation degree value for Jalan LMU Nurtanio was 0.73 and for

Jalan Abdul Rahman Saleh it was 0.69, so the service level category for Jalan LMU Nurtanio was C, and the service level of Jalan Abdul Rahman Saleh is B.

2. The PTV VISSIM program can be used to simulate traffic flow conditions at level crossings on Jalan LMU Nurtanio - Jalan Abdul Rahman Saleh, and the queue length for Jalan LMU Nurtanio is 207.67 m, Jalan Abdul Rahman Saleh is 252.69 m and Jalan Maleber Utara 37. 89 m, with an accuracy rate in the field of 98.55%
3. Alternative solutions to overcome problems at level crossings include enforcing laws regarding traffic rules, widening the road on Jalan LMU Nurtanio, and building flyovers/underpasses to facilitate traffic flow.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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