INTERSECTION PERFORMANCE ANALYSIS AT UNSIGNALIZED TRIPLE INTERSECTION AT KARANG TENGAH LODAYA ROAD - NAGRAK, CIBADAK-SUKABUMI

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ABSTRACT

Efficient and safe intersections are an important aspect of traffic management in urban areas. An unsignalized intersection is one of the most common types of intersections. This study aims to analyze the performance of road junctions at unsignalized intersections on Jalan Karang Tengah Lodaya-Simpang Nagrak, Cibadak-Sukabumi. The data collection method was carried out through field surveys by observing traffic at intersections for 3 days on Monday April 3 2023, Wednesday April 5 2023, and Sunday April 9 2023. Parameters observed included delay time, average speed, density level, and accident rate. The collected data was analyzed according to the MKJI 1997 guidelines for calculating capacity and delay at intersections. The results of capacity analysis are used to assess the level of traffic service at this intersection, which is then classified into different levels of service (LOS). optimal. High delay times occur during peak hours, namely at 07:00 – 08:00 (morning), and 16:00 – 18:00 (afternoon). This results in traffic congestion and affects the average speed of vehicles. The level of density also exceeds the optimal capacity of the intersection, which can result in traffic congestion and disruption. Based on the results of this analysis, it is suggested to do repairs at the intersection. Improvements that can be made include widening the road, changing the geometry of intersections, and setting vehicle priorities. By carrying out these improvements, it is expected that the performance of the road junction can be improved, reducing delay time, increasing the average speed, and reducing the risk of accidents. This research makes an important contribution to the development of transportation systems and traffic management in urban areas. It is hoped that the results of this research can become a reference for local governments in planning the improvement and development of more efficient and safe intersections.

Keywords: *performance analysis, crossroads, unsignalized intersection.*

I. INTRODUCTION

Rapid economic growth and population growth in many parts of Indonesia have had a significant impact on the transportation sector. Sukabumi City, as one of the centers of activity in West Java, is no exception to the significant increase in traffic volume. Road intersections, as the meeting point of traffic flow from several directions, are vital elements in the transportation network and need to be managed efficiently to ensure smooth, safe and convenient operation for road users.

One of the intersections that plays an important role in the transportation system of Sukabumi City is the triple intersection at Karang Tengah Road - Nagrak Intersection. This intersection has unsignalized characteristics, which means that traffic flow is governed by certain priority rules and driver awareness. With the growing number of vehicles, an in-depth analysis is required to evaluate the performance of this intersection to identify problems and develop effective improvement strategies..

The importance of performance analysis of the unsignalized triple intersection at Karang Tengah Road - Nagrak Intersection has attracted the attention of researchers and practitioners in the field of transportation. In this context, this study aims to analyze the performance of the triple intersection with reference to the 1997 Indonesian Road Capacity Manual (MKJI). The 1997 MKJI has proven to be a reliable guide in analyzing road and intersection capacity, and provides practical guidance in identifying potential improvements that can increase traffic efficiency.. [1]

The research will focus on several key aspects, including the collection of accurate traffic data, analysis of the actual capacity of the intersection based on MKJI 1997, evaluation of the average vehicle waiting time, and identification of potential improvements to the intersection geometry or traffic arrangements that could improve the intersection performance. The results of this study are expected to make a valuable contribution to decision making in transportation planning and management in Sukabumi City.

By utilizing a careful analytical approach and using MKJI 1997 as the basis for the methodology, this research will yield important information on the performance of the three unsignalized intersection at Karang Tengah Road - Nagrak Intersection. As such, this research has objectives that are in line with efforts to develop an adaptive and efficient transportation infrastructure, which in turn will help to improve the performance of the intersection. will provide real

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benefits to the people of Sukabumi in terms of mobility and accessibility.

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A. Research Problem Statement

The problem formulations in this research are

1. The performance of the intersection is allegedly low
2. The contribution of each vehicle to the low performance of the intersection

It is expected that this research will be able to answer the following research questions.

1. How is the performance of the intersection?
2. What is the contribution of LV, MC, HV to the low performance of the intersection?

B. Purpose Of The Research

The objectives of the performance analysis of the three unsignalized intersection at Jalan Karang Tengah Lodaya - Nagrak Intersection, Sukabumi are to::

1. Evaluate the performance of the intersection's capacity to accommodate through traffic.
2. Identify the causes of congestion and factors that reduce the level of service at the intersection.
3. Design an appropriate solution to improve the performance of the road intersection, taking into account the factors affecting traffic in the area which aims to create safer and more efficient traffic conditions for the community.

II. RESEARCH BACKGROUND

A. Definition of Intersection

A road intersection is a place where two or more roads converge and vehicles from different directions meet and converge. Road intersections can be signalized or unsignalized, depending on whether there is a traffic signaling system installed there or not. Road intersections may be three-, four-, or other types, and may be equipped with facilities such as sidewalks, pedestrian paths, and bicycle lanes.

According to WIKIPEDIA, an intersection is a node in the transportation network where two or more roads meet, where traffic flows conflict. To control this conflict, traffic rules are established to determine who has the right to use the intersection first. [2]

Intersection performance analysis involves the collection of traffic data, such as vehicle volumes, average speeds, and delay times. The data is then analyzed using mathematical and simulation methods to evaluate the performance of the intersection under various traffic conditions.

B. Types of Intersections

Types of intersections, In the transportation network, road users are free to use their own preferred route, which is a major characteristic of road transportation. Therefore, for the safety and efficiency of traffic flow that wants to move from one road section to another, an intersection is required. Intersection Types Based on Control System, that is :

1. Unsignalyzed Intersection,

   An unsignalized intersection is an intersection that does not use signals in its arrangement, an intersection without traffic lights where the right of way is given priority to traffic from the left, Notations, terms and definitions specific to unsignalized intersections there are several terms used. Notations, terms and definitions are divided into 3, that is : Geometric Condition, Environmental Conditions and Traffic Conditions.

2. Signalyzed intersection

   A Signalized intersection is an intersection where vehicle movements are regulated by traffic signals. According to MKJI [1], The purposes of using signaling at intersections include: Avoiding traffic conflicts at intersections, Make it easier for pedestrians to cross, and Reducing the level of traffic accidents due to vehicles traveling in opposite directions

C. Intersection Traffic Conflicts

Problems at intersections arise due to traffic movements coming from each arm of the intersection (left turn, straight turn, and right turn) all using the same space/place and at the same time, causing conflict points in the intersection space.

The more conflict points that occur in the intersection space, the more it will hamper the process of traffic flow movement and this will lead to a reduction in the capacity of the intersection and will increase the possibility of accidents (Tamin, 2008).

Unsignalized Intersection Capacity MKJI (1997) [1] defines that capacity is the maximum traffic flow that can be maintained (fixed) on a road section under certain conditions expressed in vehicles / hour or smp / hour.

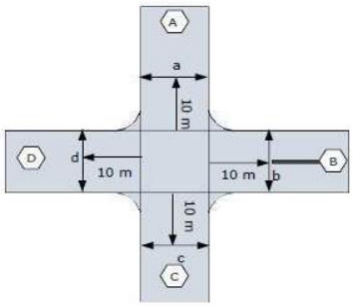
The total capacity for all arms is the result of multiplying the basic capacity (Co), which is the capacity under certain conditions (ideal) and adjustment factors (F) by taking into account the effect of field conditions on capacity. The formulation of intersection capacity according to MKJI 1997 is written as follows:

$$C = C_o \times F_W \times F_M \times F_{CS} \times F_{RSU} \times F_{LT} \times F_{RT} \times F_{MI} \quad (1)$$

*D. **Approach width and intersection type***

a) Approach Width (W)

Approach width is where vehicles enter an arm of an intersection. (MKJI, 1997) [1]. The approach width at unsignalized intersections for minor roads can be determined by Equation 3.2. The approach width for major roads is calculated by Equation 3.3, while the average approach width (W1) is calculated by Equation 3.4. For more details can be seen in Figure 3.3.



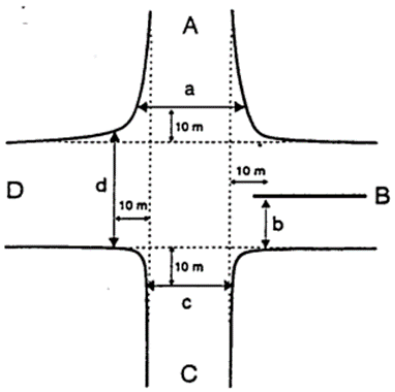
WAC = (WA + WC)/2 ……..(3. 2)

WBD = (WB + WD)/2 …….. (3. 3)

W1 = (WA + WC + WB + WD) /arms total....(3. 4)

b) Number of Lanes

The number of lanes used for calculation purposes is determined from the average approach widths of minor roads and major roads as follows. Determine the number of lanes based on the average approach widths of minor and major roads from Figure B-1:2 below, and enter the results in Columns 9 and 10..



Lebar rata-rata pendekat minor dan utama W_{AC}, W_{BD} (m)		Jumlah lajur (total untuk kedua arah)
W_{BD} = (b+d/2)/2	< 5,5	2
	≥ 5,5	4
W_{AC} = (a/2+c/2)/2	< 5,5	2
	≥ 5,5	4

c) The intersection type

Determines the number of arms and the number of lanes on the major and minor roads at the intersection with a three-digit code, see Table 2.2 The number of arms is the number of arms with traffic entering or exiting or both. Enter the result of the intersection type (IT) into column 11.. (MKJI 1997)

Kode IT	Number of intersection arms	Number of minor road lanes	Number of lanes on main road
322	3	2	2
324	3	2	4
342	3	4	2
422	4	2	2
424	4	2	4

E. Traffic Behavior

a) Degree of Saturation

The degree of saturation (DS) is the ratio of traffic flow (smp/hr) to capacity (smp/hr), can be written with the following equation:

$$DS = \frac{Qsmp}{C} \quad (2$$

b) Delay (D)

According to MKJI (1997) [1], Delay is the additional travel time to pass through an intersection when compared to a situation without an intersection. The delay value affects the value of vehicle travel time. The higher the delay value, the higher the travel time.

The intersection delay (D) is calculated using the following equation:

D = DG + DTi (sec/smp) (3)

c) Queuing Opportunities (QP%)

The limit value of the QP% queuing opportunity (%) is determined from the empirical relationship between the QP% queuing opportunity and the degree of saturation DS. Queuing opportunities with upper and lower limits can be obtained using the following formula below (MKJI 1997) :

Upper limits:

QPa = (47,71 x DS) – (24,68 x DS2) + (56,47 x DS2) (4)

Lower limits :

QPb = (9,02 x DS) + (20,66 x DS2) + (10,49 x DS2) (5)

III. RESEARCH METHOD

The method used by the author is descriptive method or known as survey method. with survey method. Descriptive method is a method in researching the status of a group of people, an object, a set of conditions

a group of people, an object, a set of conditions, a system of thought, or an event in the present. The purpose of this descriptive research is to make descriptive, description or painting systematically, actual and accurate regarding the facts, characteristics and relationships between the

phenomena investigated.your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

A. Location and Time Of Research

This research was conducted at the intersection of roads at the intersection of three unsignalized intersections on Jalan Karang Tengah Lodaya - Nagrak Intersection, Cibadak-Sukabumi. Within a period of 1 week where three days of research time were taken, namely on April 03, 05 and 09, 2023, with data collection taken in three sessions where one session took four hours. Then the data is taken every fifteen minutes, in accordance with the rules of the Indonesian Road Capacity Manual (MKJI 1997) [1], where:

1. Monday April 03, 2023
   Morning 06.00-10.00
   Afternoon 11.00-15.00
   Evening 16.00-19.00
2. Wednesday April 05, 2023
   Morning 06.00-10.00
   Afternoon 11.00-15.00
   Evening 16.00-19.00
3. Sunday April 09, 2023
   Morning 06.00-10.00
   Afternoon 11.00-15.00
   Evening 16.00-19.00

The selection of observation time is based on the beginning of the working day, weekdays and holidays.

B. Research Data Analysis

The analysis stage is a follow-up after data processing has been completed, the purpose of this stage is to understand and analyze the processing results in depth, especially in terms of:

1. Analysis using the MKJI 1997 method using USIG-I and USIG II forms.
2. Knowing the performance of the intersection, the analysis is based on MKJI 1997. Meanwhile, to get the emp value at the intersection using the capacity method.
3. Assess the number of vehicles occurring at unsignalized intersections by calculating the number of vehicles that successfully exit and enter through the intersection.
4. Calculate the capacity (C), Degree of Saturation (DS), Delay (D), Queuing Opportunity (QP) with USIG-I and USIG-II Forms according to the provisions of MKJI 1997.

C. Data collection method

In conducting research, the research data taken includes:

1. Primary data

   Primary data is data obtained or collected directly in the field by researchers from the person concerned.
   - Geometric conditions, namely by measuring the road body, road shoulders, and intersection types
   - Traffic volume contains recording the number of vehicles passing through the intersection in the direction of turning left right or straight with classification according to the type of vehicle and its movement.
   - Environmental conditions include city size classes, road environment types and side obstacle classes needed for calculations.
2. Secondary Data
   Secondary data is the researcher's effort to collect data taken from primary sources. Primary data from this study are:

   Data on the population of Sukabumi Regency in 2023 obtained from the Population Service of Sukabumi Regency, which data will be used to determine the city size class. The population of Sukabumi Regency is 2.73 million people.

D. Research Tools

In accordance with the data requirements needed, to get accurate results the following tools are needed.

1. survey form which is used to record the type and number of vehicles.
2. Hand counter used to cross the intersection
3. Gps mapping (geodetic) to find out the width of the main road body, minor, and shoulder.
4. stationery is used as a recording tool in the field
5. watch/stopwatch to manage time efficiency in the field

E. Research Plan

1. Measured variables

   The main variables measured are the number of each vehicle passing through the specified intersection, namely:

   - Light Vehicles (LV)/Passenger cars and small trucks.
   - Heavy Vehicles (HV)/ Buses, 2 axle trucks and combination trucks.
   - Motorcycles (MC)/ Motorcycles and 3-wheeled vehicles.
   - Non-motorized vehicles (UM)/ Bicycles and pedicabs.

2. Preliminary Survey

   This preliminary survey aims to find out preliminary data on traffic flow patterns, survey locations to be selected and peak hours and also environmental conditions around the intersection.

F. ***Stage Discussion***

Analysis and processing are carried out based on the data that has been obtained, then grouped according to the identification of the type of problem so that an effective and directed problem solving analysis is obtained,

IV. RESULTS AND DISCUSSION

A. Data Description

Traffic flow research was carried out at an unsignalized intersection in Karang Tengah-Lodaya. This research takes traffic flow data from three types of vehicles, namely Motorcycle (MC), Light Vehicle (LV), Heavy Vehicle (HV. Data collection is carried out simultaneously on each road section at each location during the morning hours, namely 07.00-08.00 and in the afternoon at 16.00-17.00 WIB.

Based on surveys conducted in the field, sample data can be obtained in the form of traffic volume, vehicle type and type of vehicle. The data used for analysis in this research is traffic volume data (cars, motorbikes and trucks).

B. Vehicle volume

Vehicle volume was calculated using the MKJI theory for three days (03.05 and 09 in April 2023) and each day was carried out at two time intervals.

- Interval I (07.00-08.00)
- Interval II (16.00-17.00)

Period :		Day 1			
		volume			
No.	Time	Motorcycle (MC)	Car (LV)	Truck (HV)	Amount
1	07.00-08.00	2877	782	118	3777
2	16.00-17.00	2778	625	138	3541
		77.27%	19.23%	3.50%	100.00%

Table 1 *Vehicles on Day 1*
(Source: Field Results Data Documentary)

On the first day of vehicle volume research, Monday 03 April 2023, there was a spike in motorized vehicles. This is possible because that day is the day when people start their activities at the beginning of the week. The spike in vehicle volume occurred in the first interval period 07.00-08.00 with a vehicle volume value of 3777 vehicles/hour.

AVERAGE DAILY RATE OF VEHICLES PER HOUR BASED ON VEHICLE COMPOSITION					
Survey Location:		Central-Lodaya Reef			
Date and time :		Wednesday, 05 April 2023			
Period :		Day 2			
No.	Time	Motorcycle (MC)	Car (LV)	Truck (HV)	Amount
1	07.00-08.00	2095	763	117	2975
2	16.00-17.00	3193	772	104	4069
		75.07%	21.79%	3.14%	100.00%

Table 2 *Vehicles on Day 2*
(Source: Field Results Data Documentary)

On day second vehicle volume research Wednesday 05 April 2023, happened surge on vehicle motorized . Increase in vehicle volume happen in the II interval period 16.00-17.00 with vehicle volume value 4069 kend / hour.

AVERAGE DAILY RATE OF VEHICLES PER HOUR BASED ON VEHICLE COMPOSITION					
Survey Location:		Central-Lodaya Reef			
Date and time :		Wednesday, 05 April 2023			
Period :		Day 2			
No.	Time	Motorcycle (MC)	Car (LV)	Truck (HV)	Amount
1	07.00-08.00	2095	763	117	2975
2	16.00-17.00	3193	772	104	4069
		75.07%	21.79%	3.14%	100.00%

Table 3 *Vehicles on Day 3*
(Source: Field Results Data Documentary)

On day third vehicle volume research Saturday 09 April 2023, happened surge on vehicle motorized . Increase in vehicle volume happen at interval I period time 07.00-08.00 with vehicle volume value 3152 vehicles / hour.

a) Average Daily Vehicle Speed (LHR)

Rate daily average vehicle is obtained from cumulative total vehicle volume day First until with day day to three , with amount day study as a dividing factor .

On day third vehicle volume research Saturday 09 April 2023, happened surge on vehicle motorized . Increase in vehicle volume happen at interval I period time 07.00-08.00 with vehicle volume value 3152 vehicles / hour.

AVERAGE DAILY RATE OF VEHICLES PER HOUR BASED ON VEHICLE COMPOSITION					
Survey Location:		Central-Lodaya Reef			
Date and time :		Monday, Wednesday, Sunday, 03, 05, 09 April 2023			
Period :		Day 1 to day 3			
No.	Time	Motorcycle (MC)	Car (LV)	Truck (HV)	Amount
1	07.00-08.00	7274	2293	1794	11361
2	16.00-17.00	8344	1794	520	10658
		70.93%	18.56%	10.51%	100.00%

Table 4 *Average daily rate*
(Source: Field Results Data Documentary)

C. Left Turn Ratio Table

1. Left Turn Rasio

The left turn ratio is obtained using the formula:

$$P_{LT} = \frac{A_{LT} + B_{LT} + C_{LT} + D_{LT}}{A+B+C+D}$$

$$P_{LT} = \frac{680.8+190}{6875.6}$$

$$P_{LT} = 0.1266$$

2. Right Turn Rasio

The forward turning ratio is obtained using the formula:

$$P_{RT} = \frac{A_{RT} + B_{RT} + C_{RT} + D_{RT}}{A+B+C+D}$$

$$P_{RT} = \frac{204.7 + 755.8}{6875.6}$$

$$P_{RT} = 0.1397$$

Where :

P_{LT} = Left turn ratio

P_{RT} = Right turn ratio

A_{LT}-D_{LT} = Number of vehicles on each arm (left) in units pcu/hour

A_{RT}-D_{RT} = number of vehicles on each arm (right) in units pcu/hour

A+B+C+D = Total vehicles pcu/hour

The average left turn ratio value for three days at the unsignaled intersection in Karang Tengah-Lodaya, CIbadak is 0.085 units, which means that 8.5% of the number of vehicles/hour make left turns, both from the direction of Cibadak towards the road. minor, namely towards Nagrak or from Nagrak towards Jl. Sukabumi city.

Meanwhile, the average right turn ratio value during the three days of the study was 0.1397 units, which means that 13.97% of the total number of vehicles/hour made a right turn, namely from the direction of Sukabumi City towards Jln Nagrak Minor, or from the direction of Jl. . Minor Nagrak towards J. Cibadak.

D. Left Turn Ratio

The left turn ratio is obtained using the formula:

$$P_{LT} = \frac{A_{LT} + B_{LT} + C_{LT} + D_{LT}}{A+B+C+D}$$

$$P_{LT} = \frac{680.8+190}{6875.6}$$

$$P_{LT} = 0.1266$$

E. Right Turn Ratio

The forward turning ratio is obtained using the formula:

$$P_{RT} = \frac{A_{RT} + B_{RT} + C_{RT} + D_{RT}}{A+B+C+D}$$

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BIBLIOGRAPHY

[1] Directorate General Build Indonesian Clans Department Work General , Jakarta :

[2] *Indonesian Road Capacity Manual* (MKJI 1997) No signal intersection.

[3] WIKIPEDIA https://id.wikipedia.org/wiki/Crossroads Understanding road intersections.

[4] Hariyanto 2004 https://text-id.123dok.com Types of intersections Types of intersections Characteristics of intersections

[5] Marchyano Beltazazar Relict Cabi . Journal Civil Statik Vol.3 No.7 July 2015 (515-530) ISSN: 2337-6732 PERFORMANCE ANALYSIS OF INTERSECTIONS WITHOUT SIGNALS (CASE STUDY: SIMPANG THREE RINGROAD-MAUMBI)

[6] Blessings Rahmandika , Wahyu Widodo , Modeling Intersection Not Signal Become Intersection Signal Using Vissim Software (Study Case : Junction Jalan Agro, Depok , Sleman) . http://repository.umy.ac.id/

[7] WIKIBUKU Traffic Engineering/Characteristics of Engineering traffic flow So Cross / Characteristics current Then cross - Wikibooks Indonesian (wikibooks.org)