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TRAFFIC FLOW ANALYSIS AT UNSIGNAL JUNCTION (CASE STUDY: INTERSECTION OF JL. MANDALA – JL. RAYA TLANAKAN PAMEKASAN CITY)

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ABSTRACT

We often find traffic problems in big cities, and even small cities such as Pamekasan. The problem of congestion and traffic congestion often occurs at crossroads, especially the intersection of Jl. Mandala – Jl. Raya Tlanakan, Pamekasan City. The reduced performance of the intersection will cause losses due to a decrease in speed, an increase in delays and vehicle queues and a decrease in environmental quality. Parameters of an unsignalized intersection include capacity, degree of saturation, delay and queuing opportunity. From the analysis, the maximum C (capacity) value of 2257.83 smp/hour does not exceed the basic capacity (Co = 2700 smp/hour). The low capacity classification occurring on Thursday, December 9, 2021 at 18.00 – 21.00 WIB. The highest DS (Degree of Saturation) value is 0.63, and the largest D (Intersection Delay) value is 19.17 sec/smp occurred on Thursday, December 9, 2021 at 06.00 – 10.00 WIB. Then the capacity obtained at the intersection of Jl. Mandala – Jl. Raya Tlanakan, Pamekasan City is still feasible to accommodate the traffic volume because it does not exceed the basic capacity of the intersection. However, to overcome congestion at intersections, especially during rush hour/working hours, it is necessary to supervise and secure from related parties.

Keywords: *Performance of Intersections; Unsignalized Intersections; Traffic Volume.*

1. Introduction

In the current era, the function of the road has a role as a transportation infrastructure which is a necessity for humans. One of them is the provision of adequate road conditions, both physical and non-physical, both in number and level of need, it is hoped that the results of development that have been achieved can be felt by the whole community, especially for people who already have private vehicles [8].

The success of current development can be seen from the increasingly advanced growth in all fields which in fact demands an increase in transportation needs that are in harmony and balance with the implementation of development. The success of this development also encourages an increase in the volume of vehicles due to the transportation needs in supporting the implementation of development. There have been many visible impacts that are very influential, including the level of congestion that is getting bigger due to the imbalance of adequate facilities such as roads [11]. Transportation has an important role in supporting community activities in a country. Transportation problems in Indonesia are one of the things that are difficult to overcome [6].

Population growth and increasing people's purchasing power resulted in increased movement of people and goods, thus causing an even greater number of vehicle movements in an area [2]. One of the important factors in the effort towards a good transportation infrastructure system is the ability of road performance, especially the performance of intersections as one part of the overall road system [7]. In line with the rapid development of the city, the demands of increasingly

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congested traffic, and public demand for increasingly large vehicles require attention and work assessment for intersection conditions [13].

Intersections are an integral part of all road systems. When driving in the city, one can see that most roads in urban areas usually have intersections, where the driver can decide to continue or turn and change roads.

Crossroads are places where traffic conflicts occur. Usually traffic conflicts occur because the intersection is a place where vehicles from various directions meet and change direction also due to the high traffic volume that is not supported by the capacity of the intersection. By decreasing the performance of the intersection, it will cause losses to road users due to a decrease in speed, an increase in delays, and vehicle queues and a decrease in environmental quality. The parameters used to assess the performance of an unsignalized intersection include capacity, degree of saturation, delays and queuing opportunities [9].

Pamekasan is an area that has traffic conflicts at the intersection. One example is at the intersection of Jl. Mandala – Jl. Raya Tlanakan. This intersection is an unsignalized intersection. The condition of the intersection supports the occurrence of traffic jams and accidents, because the area is a road to the center of the economy, office centers, schools, campuses and recreational areas. Seeing the things mentioned above, the analysis of the capacity and performance level of the Jl. Mandala – Jl. Kingdom of Tlanakan needed.

2. Material and Methods

An intersection is four intersections between two or more roads, where the meeting creates conflict points due to traffic flow at the intersection. The road sections at the intersection are used together, so the capacity of the road section is limited by the capacity of the intersection at each end. Safety problems usually arise at intersections, the result is that network capacity and safety are determined by intersections, where intersections are the main thing that must be considered in urban transportation management [3].

The intersection is a place that is prone to accidents because of the conflict between the movement of vehicles and the movement of other vehicles [10]. Unsignaled intersections are intersections that do not have traffic lights to help regulate vehicles at the intersection, but there are several methods of controlling the intersection that must be realized and carried out by road users, such as priority signals, give way (yield), stop or canalization. This is done so that traffic activities that occur at intersections are passed in a more orderly and safe manner [4].

The increasing volume of vehicles causes the road capacity to become smaller if it is not balanced with an increase in road network and capacity [12]. Road capacity is the maximum amount of vehicle traffic that can be accommodated on a road section during certain conditions (geometric design, environment, and traffic composition) which can be determined in passenger units (pcu/hour) [5]. Congestion is a situation or condition where traffic is stopped or even stopped due to the large number of vehicles exceeding the road capacity. Traffic problems in the form of congestion are things that require more attention. So that it also affects the comfort of the community in their activities [1].

At the intersection of Jl. Mandala – Jl. Raya Tlanakan, vehicles from the south that will make a right turn to the east never pay attention to the condition of the vehicle behind it that will move straight or the vehicle from the opposite direction (north). So that the conflict that has occurred at the intersection of Jl. Mandala – Jl. Raya Tlanakan. One way to resolve the conflict is the awareness that road users or vehicle drivers who will make a right turn must be more careful by paying attention to vehicles coming from the opposite direction or vehicles from the same direction following behind them.

2.1. Preliminary survey

The purpose of this preliminary survey is to determine the volume of vehicles passing through the intersection of Jl. Mandala – Jl. Raya Tlanakan, so that the degree of saturation and delay of the intersection can be known. Before the survey is carried out, it is necessary to know the actual field conditions so that data collection can produce accurate data. Field conditions include:

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1. Survey Location Sketch
   A sketch of the survey location needs to be made to place each post to calculate the traffic volume.
2. Traffic Density
   Traffic density needs to be reviewed first so that it can determine the number of people needed to conduct a survey at each post to calculate the volume of vehicles and get accurate results.

2.2. Determining Research Variables

The variables that are considered to affect the performance of the unsignaled phase at the intersection of Jl. Mandala – Jl. Raya Tlanakan are as follows:

1. Capacity is the maximum traffic flow that can be maintained (fixed) on a section of the road under certain predetermined conditions (basic conditions).
   a. Geometric (intersection type, approach mean width, main road median type)
   b. Environment(city size class, road environment type, side barriers, non-motorized vehicle ratio)
   c. Traffic (left turn ratio, right turn ratio, minor road flow ratio)
2. Degree of Saturation is the ratio of traffic flow to capacity.
3. The intersection delay is the delay caused by the intersection or the total average resistance time experienced by the vehicle when passing through the intersection.

2.3. Data Processing Method

The data obtained from the survey results from the number of vehicles passing through an unsignalized intersection, this is used to calculate the difference between vehicles passing through the intersection.

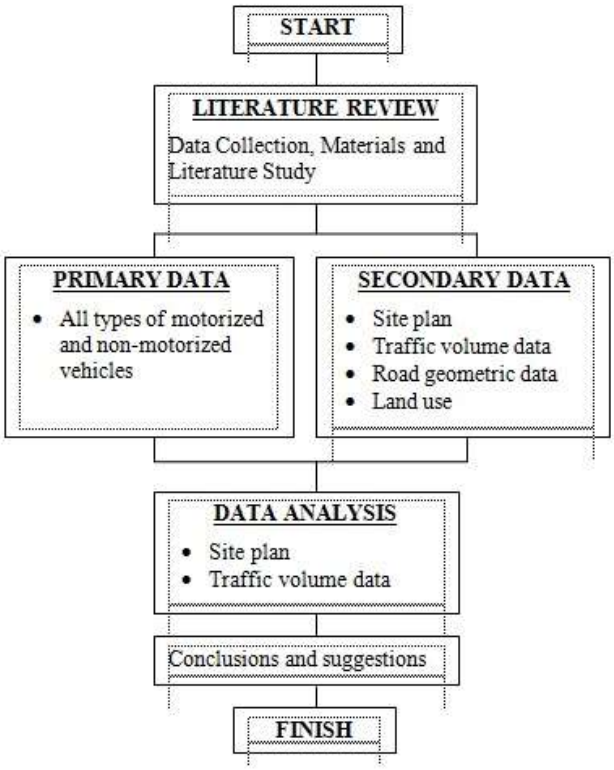

Figure 1. Research Flowchart

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3. Result and Discussion

3.1. Unsignalized Intersection Performance Measure

The following unsignalized intersection performance measures can be estimated for certain conditions with respect to geometry, environment and traffic are as follows:

a. Geometric conditions

There are several things that must be considered in the input data for geometric conditions, including sketches of geometric patterns that must be clear, the name of the main road, and the main road and arrows must also be made as a reference. Sketches should provide a good picture of an intersection about information about the width of the path, shoulders and medians. If the median is wide enough to make it possible to cross the intersection in two stoppers in the middle [15].

b. Traffic conditions

The traffic flow sketch provides traffic information needed for intersection analysis not signaling. If alternative signaling at intersections is also to be investigated, the sketch should show the movement of motorized and non-motorized traffic (vehicles/hour) on the ALT, AST, and AGT approaches and so on. ALT is a left turn movement at the A intersection arm, AST is an approach that describes a straight movement in arm A and AGT is a right turn movement also in arm A, and so on [15].

The procedure for calculating traffic flow in passenger car units (junior high school) is as follows [15]:

1. Traffic flow data classification per hour for each movement. Convert it to smp/hour by multiplying it by emp for each class of vehicle. Where for LV multiplied by 1, for HV multiplied by 1.3 and MC multiplied by 0.5.
2. Calculation of turn ratio and minor road ratio. A and B are approaches to the main road arm while C is an approach to the minor road arm.

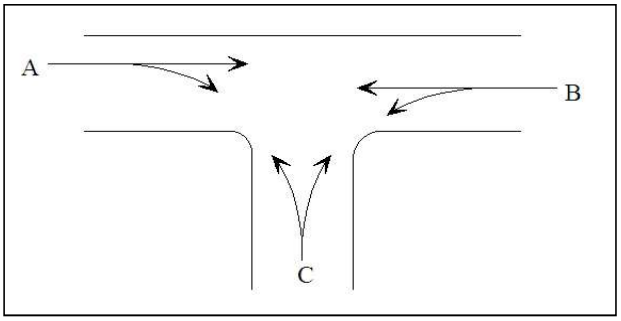

Figure 2. Traffic Flow Variable

The total traffic flow volume can be from the total maximum traffic flow of each road segment (main road and minor road).

$$Q\ TOTAL = A + B + C \quad (1)$$

c. Environmental conditions

Environmental condition data is very influential in analyzing data, for that there are three main parts that will be of concern. The three parts are [15]:

1. City size class

Enter the estimated population of all urban areas in soul units [15].

2. Type of road environment

The road environment is classified into classes according to the land use and accessibility of the road from surrounding activities. It is determined qualitatively from traffic techniques [15].

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Table 1. City size class

City Size	Total Population (Million People)
Very small	< 0,1
small	0,1 – 0,5
Currently	0,5 – 1,0
Big	1,0 – 3,0
Very large	> 3,0

3. Side resistance class

Side barriers show the effect of roadside activities at intersections on traffic departing flows, for example pedestrians walking or crossing lanes, city transportation and buses stopping to pick up and drop passengers, vehicles entering and leaving the yard and off-road parking lots. Side barriers are determined qualitatively by considering traffic techniques as high, medium or low [15].

According to MKJI 1997, side barriers are divided into 4 (four) of the side activities of the road segment, each of which has a different weight to capacity, including:

1. For pedestrians having a weight of 0.5
2. Parking/stopping vehicles have a weight of 1.0
3. Vehicles entering/exiting the road have a weight of 0.7
4. A slow moving vehicle has a weight of 0.4

The frequency of the weights determines the class of side resistance, namely:

- < 100 very low, residential area
- 100 – 199 low class, residential area
- 300 – 499 medium class, industrial area with few shops on the street
- 500 – 899 high class, commercial area, roadside activities
- > 900 very high class, commercial area/with market activity

$$PLT = \frac{QLT}{QTotal} \quad (2)$$

$$PRT = \frac{QRT}{QTotal} \quad (3)$$

Table 2. Minor Road Flow Ratio (FMI) Adjustment Factor

IT	FMI	PMI
422	$1,19 \times PMI^2 - 1,19 \times PMI + 1,19$	0,1 – 0,9
424	$1,66 \times PMI^4 - 33,3 \times PMI^3 + 25,3 \times PMI^2 - 8,6\ PMI + 1,95$	0,1 – 0,3
444	$1,11 \times PMI^2 - 1,11 \times PMI + 1,11$	0,3 – 0,9
322	$1,19 \times PMI^2 - 1,19 \times PMI + 1,19$	0,1 – 0,5
	$-0,595 \times PMI^2 + 0,595 \times PMI^3 + 0,74$	0,5 – 0,9
342	$1,19 \times PMI^2 - 1,19 \times PMI + 1,19$	0,1 – 0,5
	$2,38 \times PMI^4 - 2,38 \times PMI^3 + 1,49$	0,5 – 0,9
324	$1,66 \times PMI^4 - 33,3 \times PMI^3 + 25,3 \times PMI^2 - 8,6\ PMI + 1,95$	0,1 – 0,3
344	$1,11 \times PMI^2 - 1,11 \times PMI + 1,11$	0,3 – 0,5
	$-0,555 \times PMI^2 + 0,555 \times PMI + 0,69$	0,5 – 0,9

$$PMI = \frac{QMI}{QTotal} \quad (4)$$

$$DTMI = (QTotal \times DTI - QMA \times DTMA) / QMI \quad (5)$$

for DS < 1,0

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$$DG = (1 - DS) \times (PT \times 6 + (1 - PT) \times 3) + DS \times 4 \quad (6)$$

$$\text{for } DS \geq 1{,}0 \text{ , } DG = 4$$

$$D = DG + DT1 \quad (7)$$

3.2. Crossing Movement Encounter Type

From the various forms, nature and purpose of vehicle movement in the intersection area, there are two basic types of traffic movement at the intersection, namely:

1. Diverging
2. Marging

3.3. Conflict Point At the Crossroads

In the intersection area, vehicles and pedestrians will intersect at a point of conflict, this conflict will slow down movement and is also a potential location for collisions (accidents). Traffic flows that are affected by conflict at an intersection have complex behavior, every movement to turn left, turn right or go straight each faces a different conflict and relates to the behavior of the movement [15].

3.4. Intersection Arrangement with Traffic Lights

A traffic light is a device that can be operated manually, mechanically or electrically to regulate roads and stop vehicles. The traffic light device consists of a pole, a lamp head with three lanterns of different colors, namely red, yellow and green.

3.5. Vehicle Characteristics

In this study the types of vehicles that are meticulously grouped into four types with the following characteristics and definitions:

1. Light Vehicle (LV)
   Two-axle motorized vehicles with 4 wheels and an axle distance of 2.0 – 3.0 m (covering: passenger cars, oplets, microbuses, and small trucks according to the Bina Marga classification system).
2. Heavy Vehicle (HV)
   Motorized vehicles with more than 4 wheels (including: buses, 2 axles trucks, 3 axles trucks, and combination trucks according to the Bina Marga classification system).
3. Motorcycle (MC)
   Motorized vehicles with 2 or 3 wheels (including: motorcycles and 3-wheeled vehicles according to the Bina Marga classification system).
4. Non-Motorized Vehicles (UM)
   Vehicles with wheels driven by humans (including: bicycles, tricycles and strollers according to the Bina Marga classification).

4. Conclusions

From the analysis carried out, several conclusions were obtained as follows:

1. Traffic flow at the unsignalized intersection at the Jl. Mandala – Jl. Raya Tlanakan, whose research object is included in the Criteria well with service level A (characteristics of free flow, low volume and high speed, the driver can choose the path of his choice). Obtained a maximum C (capacity) value of 2257.83 smp/hour does not exceed the basic capacity (Co = 2700 smp/hour) then it is included in the low capacity classification occurring on Thursday, December 9, 2021 at 18.00 – 21.00 WIB, while the DS value (The highest degree of saturation is 0.63 and the highest D value (intersection delay) is 19.17 seconds/smp which occurs on Thursday, December 9, 2021, at 06.00 – 10.00 WIB.
2. As a comparison material for this research, a follow-up survey has been carried out at the intersection of Jl. Mandala – Jl. Raya Tlanakan on Friday, December 10, 2021 with a value of C (capacity) of 2257.82 smp/hour not exceeding the basic capacity (Co = 2700 smp/hour)

then it is included in the low capacity classification at 18.00 – 21.00 WIB. The value of DS (Degree of Saturation) is 0.23 and the value of D (Delay of Intersection) is 7.89.

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