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# Alternative Methods Of Handling Three Unsignalized Intersections Using Traffic Management On Ujungrusi Highway II Adiwerna Sub-District Tegal District

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**Abstract:** Ujungrusi Highway II is an alternative route that connects Tegal regency and city, passed by various vehicles every day. The three intersections on this road have different sizes and elevations, but lack signs, road markings, and clear dividing lines, confusing road users. The presence of restaurants, stalls, and indiscriminate parking further worsens the smooth flow of traffic, exacerbated by the absence of traffic lights that trigger congestion, especially during peak hours. This study aims to analyze side barriers, evaluate intersection performance, and determine the level of congestion using the MKJI (1997) method to design solutions. Data was collected through direct observation, including traffic flow, intersection conditions, and environmental factors. The results showed that the highest volume occurred on Monday morning (06.00-08.00 WIB), with medium class side obstacles (M), an intersection capacity of 2,294.52 pcu/h, and a Degree of Saturation (DS) of 1.185. With LoS category D (25.1-40 seconds/pcu), this intersection is classified as poor, so strategic steps are needed to overcome congestion.

**Keywords:** *MKJI 1997; Triple intersection analysis; Unsignalized intersection.*

## 1. Introduction

Ujungrusi Highway II is an alternative route connecting Tegal Regency and City, used by various vehicles every day for activities such as offices, schools and businesses. This road has a triple intersection with different conditions, consisting of two 10-meter-wide main roads and a 5-meter-wide secondary road that goes uphill and has different elevations. However, this intersection lacks signage, road markings are unclear, and the dividing lines are faded, confusing road users.

The presence of restaurants, stalls and street vendors along the road causes irregular traffic flow, exacerbated by indiscriminate parking due to the absence of parking lots. The absence of sidewalks also endangers pedestrians who must walk on the main road. In addition, this intersection does not yet have traffic lights (APILL), so it is classified as an unsignalized intersection that often experiences congestion.

This study aims to identify the volume and capacity of the intersection to evaluate its performance. The analysis was conducted to determine whether the intersection is still optimal or requires intervention to improve traffic flow and safety. Therefore, this research is expected to identify problems and formulate appropriate solutions.

## 2. Theoretical Foundation

### 2.1. Traffic Management

Traffic management aims to manage vehicle flows more efficiently and smoothly by optimizing infrastructure, utilizing road space, and safely accelerating mobility [1]. It improves safety, reduces pollution, and meets current and future transportation needs by streamlining vehicle movements, reducing travel times, and improving convenience. Implementations include traffic engineering, public transport improvements, stricter regulations, and operational optimization. With a holistic approach, traffic management helps to reduce congestion and ensure smooth, safe and sustainable mobility.

### 2.2. Unsignalized Intersections

[2] Unsignalized intersections are used in locations with low minor traffic flow and less intrusive turning movements. However, drivers often make risky decisions when entering narrow gaps, jeopardizing safety and impeding traffic flow.

Traffic evaluations are needed to analyze accident rates, degree of saturation, and vehicle movement patterns. If unsignalized intersections cause delays or increase the risk of accidents, installing traffic lights may be a solution. Alternatives such as road widening, clearer signage and improved safety facilities can also be used to optimize intersection performance and improve road user safety [3]

### 2.3. Intersections Performance

Performance can be defined as the achievement or ability to do a job, while traffic refers to movement on roads. Thus, traffic performance is a description of the level of effectiveness and efficiency in the movement of various elements on the road, including vehicles and pedestrians. Traffic performance includes aspects of smooth flow, road capacity, level of resistance, and road user safety, all of which play a role in determining the extent to which the transportation system can function optimally.

a. Geometric Conditions

Sketching the geometric pattern of an intersection requires a clear description of important elements such as kerbs, road width, shoulders and medians, which affect traffic safety and flow. The design should consider technical aspects, convenience, as well as safety for all road users.

In intersection classification, major roads with higher flows are notated A and B, while minor roads with lower volumes are notated C and D, marked clockwise to facilitate analysis. Accurate sketches allow for more effective evaluation and planning, helping to identify problems and design solutions such as signage, road widening, or median adjustments to improve intersection safety and efficiency.

b. Environmental Conditions

**Table 1.** City Size Grade

| City Size | Total Population (Million) |
|---|---|
| Very Small | < 0,1 |
| Small | 0,1 – 0,5 |
| Medium | 0,5 – 1,0 |
| Large | 1,0 – 3,0 |
| Very Large | > 3,0 |

At intersections with minor roads and small turning movements, unsignalized intersections can still be used. However, if the flow on the main road is high, the risk of accidents increases as motorists often utilize narrow gaps to cross or turn. Under these conditions, an evaluation is needed to consider installing traffic lights to improve safety and vehicle flow.

c. Side Barriers

[4] Side barriers are defined as the impact of activities around the road, such as pedestrian movements, public transport stops, and the presence of other vehicles, which affect traffic behavior. The level of side barriers is determined qualitatively based on traffic engineering analysis. These side barriers can reduce road capacity and smooth traffic flow. The main factors causing side obstructions include four types of events, each of which has a different weight of influence on road performance. Therefore, in traffic planning and management, it is important to consider the level of side obstructions to optimize road efficiency and safety [5].

**Table 2.** Side Obstacle Weighting Factor

| Side Barriers Event Type | Symbol | Frequency Weight |
|---|---|---|
| Pedestrian | PED | 0,5 |
| Parking/Vehicle Stopping | PSV | 1,0 |
| Vehicles Entering and Exiting | EEV | 0,7 |
| Slow Vehicle | SMV | 0,4 |

To determine the class of side obstacles, the following formula can be used:

$$\boldsymbol{SFC = PED + PSV + EEV + SMV}$$

**Table 3.** Side Barrier Class

| Side Barrier Class | Code | Number of Occurrences per 200 m per hour | Area Conditions |
|---|---|---|---|
| Very Low | VL | < 100 | Residential, almost no activity |
| Low | L | 100 - 299 | Residential, some public vehicles |
| Medium | M | 300 - 499 | Industrial area with some shops on the side of the road |
| High | H | 500 - 899 | Commercial area, high street activity |
| Very High | VH | > 900 | Commercial area with market activity |

d. Free Flow Speed

[6] Free flow speed (FV) is the speed of vehicles at zero flow, reflecting the potential optimal speed of a road under ideal conditions. This parameter is a key indicator in traffic performance analysis.

It is measured through field surveys and analyzed using regression methods to determine the influence of factors such as road geometry, environmental conditions, and traffic characteristics. The free flow speed of light vehicles is often used as the standard of evaluation, but a more comprehensive analysis also considers the speed of heavy vehicles and motorcycles due to their different characteristics. The equation for determining the free flow speed has the following general form:

$$\boldsymbol{FV = (FV0 + FVW) \times FFVSF \times FFVCS}$$

### 2.4. Intersections Capacity

The capacity of urban road networks is influenced by the capacity of road sections and intersections, both signalized and unsignalized [7]. Poorly performing intersections can degrade the overall performance of the network even if the road segments are functioning well. Therefore, intersection evaluation is important in traffic management to prevent congestion and impediments to vehicle movement. Accurate intersection capacity calculations reflect field conditions and form the basis of traffic engineering planning. The results of this analysis are used for vehicle prioritization, traffic light installation, or redesign of intersection geometry to improve traffic efficiency and safety [8]. Capacity can be calculated using the following formula:

$$C = C0 \; x \; FLP \; x \; FM \; x \; FUK \; x \; FHS \; x \; FBKI \; x \; FBKA \; x \; FRmi$$

### 2.5. Degree Of Saturation

The degree of saturation is the ratio between the traffic flow on an approach and the road capacity. The higher the value, the greater the risk of congestion slowing down vehicle movement. If it reaches or exceeds capacity, long queues may occur, especially during peak traffic. Saturation degree analysis is important to evaluate the performance of intersections and road sections, so that measures can be implemented to reduce congestion and improve traffic flow. The degree of saturation is calculated using the following formula:

$$Dj = \frac{q}{c}$$

Description:
Dj : Degree of saturation
q : All traffic flow entering the intersection
c : Intersection capacity

### 2.6. Delay

The value of delay has a direct effect on vehicle travel time-the higher the delay, the longer the travel time. Traffic delay results from interactions between vehicles, while geometric delay is caused by deceleration and acceleration, especially when vehicles turn or stop at intersections [9]. Both types of delays affect the overall performance of the roadway, so they need to be taken into account in transportation planning and evaluation to improve the efficiency of traffic movements. Delay is calculated using the formula:

$$T = TLL + TG$$

Description:
TLL : Average traffic delay for all vehicles motorized vehicles entering the intersection from all directions.
TG : Geometric delay

### 2.7. Queuing Opportunity

Queuing probability (PA) is the probability of queuing vehicles on an intersection approach, expressed in percent and calculated based on traffic factors. The PA value is influenced by the degree of saturation (DJ), where the higher the DJ, the greater the likelihood of long queues. PA is a key indicator in assessing traffic performance at intersections, helping to evaluate whether the intersection can handle the flow of vehicles or requires improvements, such as signalization, road widening, or other traffic engineering.

Upper Limit of Opportunity:

$$PA = 47.71 \; x \; DS - 24.68 \; x \; DS2 + 56.47 \; x \; DS3$$

Lower Limit of Opportunity:

$$PB = 9.02 \; x \; DS - 20.66 \; x \; DS2 + 10.49 \; x \; DS3$$

### 2.8. Level of Services

Based on the Minister of Transportation Regulation No. 96/2015, the level of service of an intersection aims to evaluate and determine the quality of service of a road section or intersection. Level of Service (LOS) is used as an indicator of traffic operational conditions and motorists' perceptions of speed, travel time, comfort, freedom of movement, security and safety [10].

Traffic speed and volume are the main factors in determining LOS, as they affect the capacity and efficiency of vehicle movement. If volumes increase without sufficient capacity, congestion and reduced quality of service may result.

By understanding LOS, governments can design strategies to improve traffic performance through traffic engineering, infrastructure improvements, signal management, and public transportation management. Determining LOS also helps identify problems, project infrastructure needs, and reduce congestion and accident risks.

**Table 4.** Intersection Level of Service Based on Delays

| Level of Service | Delay (sec/smp) | Description |
|---|---|---|
| A | < 5 | Excellent |
| B | 5.1 – 15 | Good |
| C | 15.1 – 25 | Fair |
| D | 25.1 – 40 | Poorg |
| E | 40.1 – 60 | Very Poor |
| F | > 60 | Extremely Poor |

## 3. Research Method

The research method begins with a field survey to review the intersection conditions and collect relevant data. Prior to data collection, an observation schedule was developed to determine the appropriate days and hours to accurately record traffic conditions. Primary data included information on traffic flow, intersection geometric characteristics, and environmental conditions around the study site. Secondary data included information on population growth as well as road network maps that played a role in understanding external factors affecting traffic.

### 3.1. Research Location

The research location chosen as the research site is at the intersection of Ujungrusi Highway II, Adiwerna Subdistrict, Tegal Regency, more precisely what the surrounding community usually calls the Turunan Cunong.

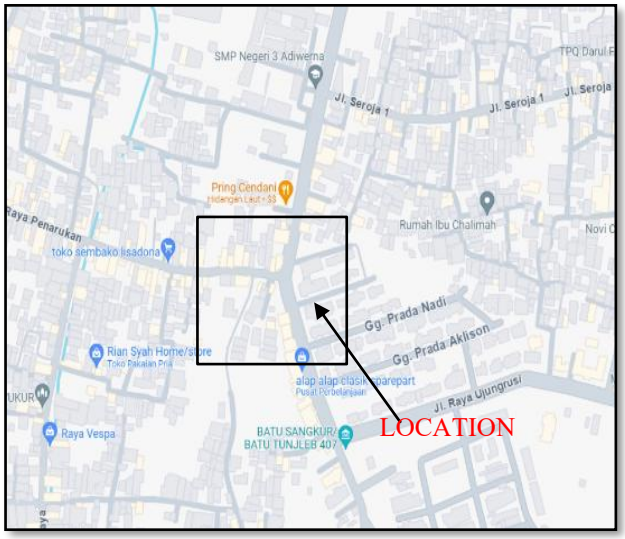


**Fig. 1.** Location Map

### 3.2. Data Collection Methods

a. Traffic Flow Volume

In this study, the volume of traffic flow was analyzed based on the number of vehicles passing through the specified observation points. Data was collected manually with the researcher recording each passing vehicle using a traffic survey form according to the categories in MKJI (1997). The survey was conducted over three days on Monday, Wednesday and Saturday to reflect weekday and weekend traffic conditions. Data collection took place during peak hours: morning (06.00-08.00 WIB), afternoon (11.00-13.00 WIB), and evening (16.00-18.00 WIB), to capture vehicle movement patterns during periods of highest intensity.

b. Side Barrier

Side obstacles in this study include various activities around the road that have the potential to disrupt the smooth flow of traffic at the intersection, such as indiscriminate parking and pedestrians crossing outside the proper place. Observations were made systematically at designated points over three days on Monday, Wednesday and Saturday to reflect weekday and weekend traffic conditions. Data were collected during peak hours: morning (06:00-08:00 am), afternoon (11:00-13:00 am), and evening (16:00-18:00 pm), when traffic intensity is highest. During data collection, roadside activities within a 100-meter radius of the Ujungrusi Highway II Interchange were counted and analyzed. The results were used to evaluate the impact of side obstacles on traffic flow and formulate solutions to reduce vehicle flow disruptions at the study site.

c. Speed

In this study, sampling was conducted using the Systematic Random Sampling method. This method uses a certain interval to determine the sample to be observed, in accordance with systematic random sampling theory. For example, if the study requires 10 samples from a total of 100 vehicles, then the sampling interval is calculated by dividing the total number of vehicles by the number of samples required, i.e. 100/10 = 10. Furthermore, vehicles that are in the 10th, 20th, 30th, and so on will be selected as research samples.

d. Intersections Performance

In this study, the analyzed intersection performance includes several main parameters, namely capacity (C), degree of saturation (DS), delay (D), queuing opportunities (QP%), and Level of Service (LOS). Intersection Level of Service (LOS) is determined based on the results of analyzing these parameters to classify intersection performance in various service categories. By understanding these indicators, the research can provide appropriate recommendations in optimizing the function of the intersection and improving traffic efficiency at the study site.

e. Literature Study

To obtain secondary data that supports this research, a literature study was conducted by looking for references from various trusted sources, such as books, research reports, and official documents from related institutions. The sources used include books that discuss transportation systems. In addition, by referring to previous research, this study can identify suitable analysis methods and solutions that have been applied in similar cases. The results of this literature study will be used as the basis for analyzing the data and formulating appropriate recommendations to improve traffic performance at the studied intersections.

### 3.3. Data Analysis Methods

In the data analysis stage, the information collected will be processed using Microsoft Excel for calculations and data visualization. Field survey data, including road geometry and traffic flow, will be entered into the LHR (Average Daily Traffic) form for further analysis.

The survey is conducted during peak hours morning (06.00-08.00 WIB), afternoon (11.00-13.00 WIB), and evening (16.00-18.00 WIB) to get an idea of traffic conditions when vehicle intensity is highest. The data obtained will be calculated using the LHR calculation table with a standard formula to ensure the accuracy of the results. Graphs are also created to visualize traffic trends and facilitate analysis. After all aspects have been analyzed, the researcher will evaluate the results and develop alternative solutions to overcome congestion at the Tiga Jalan Raya II Ujungrusi Intersection, Adiwerna District, Tegal Regency. The proposed solution will consider technical aspects and traffic policies to improve the smoothness and safety of driving in the area.

## 4. Results And Discussion

### 4.1. Traffic Volume Analysis

Observations at the Ujungrusi Highway II Triple intersection located in Adiwerna Subdistrict, Tegal Regency, revealed vehicle volume data at each hour. The data is grouped by type of vehicle, namely heavy vehicles, light vehicles, and motorcycles. The results of the analysis of the calculation of traffic volume at Ujungrusi Highway II Triple intersection located in Adiwerna District Tegal Regency known peak hour highest traffic volume occurred on Monday, December 2, 2024 hours 06.00 - 08.00 pm. Peak hour volume data can be seen in the table below:

**Table 5.** Peak Traffic Volume Hours

| **Traffic Flow from Approach Direction** | | **HV** | **LV** | **MC** | **MV** |
|---|---|---|---|---|---|
| **Monday, 2nd December 2024, 6am - 8pm** | | **v/h** | **v/h** | **v/h** | **v/h** |
| Minor Road A (Jatibarang) | LT (Left Turn) | 21 | 178 | 272 | 471 |
| | ST (Straight) | 0 | 0 | 0 | 0 |
| | RT (Right Turn) | 12 | 159 | 264 | 435 |
| **Minor Road A Total** | | **33** | **337** | **536** | **906** |
| Mayor Road B (Slawi) | LT (Left Turn) | 12 | 124 | 219 | 355 |
| | ST (Straight) | 23 | 231 | 303 | 557 |
| | RT (Right Turn) | 0 | 0 | 0 | 0 |
| **Mayor Road B Total** | | **35** | **355** | **522** | **912** |
| Mayor Road C (Tegal) | LT (Left Turn) | 0 | 0 | 0 | 0 |
| | ST (Straight) | 25 | 220 | 298 | 543 |
| | RT (Right Turn) | 16 | 126 | 216 | 358 |
| **Mayor Road C Total** | | **41** | **346** | **514** | **901** |
| **Grand Total** | | **109** | **1038** | **1572** | **2719** |
| **Percentage (%)** | | **4.01** | **38.18** | **57.82** | **100.00** |

Based on the table above, it can be seen that the traffic flow at the Intersection of Ujungrusi Highway located in Adiwerna District Tegal Regency reached its highest peak on Monday (weekday) between 06.00 - 08.00 WIB, with the distribution of the number of vehicles as follows: heavy vehicles (HV) as much as 4.01%, light vehicles (LV) as much as 38.18%, motorcycles (MC) as much as 57.82%. The most dominant vehicle passing through the intersection is a motorcycle, followed by light vehicles and heavy vehicles.

### 4.2. Free Flow Speed

Based on the results of data analysis from the table below, the free flow speed on Jalan Raya II Ujungrusi (major road) shows variations based on the type of vehicle passing. The free flow speed for heavy vehicles (HV) was recorded at 36.98 km/hour, light vehicles (LV) at 40.42 km/hour,

and motorcycles (MC) at 36.98 km/hour. Meanwhile, the free flow speed on Jalan Raya Penarukan (minor road) tends to be lower than that of major roads. Heavy vehicles (HV) have a free flow speed of 30.10 km/h, light vehicles (LV) of 33.54 km/h, and motorcycles (MC) of 30.10 km/h. This speed difference can be influenced by various factors. This data forms the basis for evaluating the performance of road sections and intersections and determining appropriate traffic management strategies to improve the efficiency of vehicle movement.

**Table 6.** Free Flow Speed Value

| No | Road Section | Speed (km/h) | | |
|---|---|---|---|---|
| | | HV | LV | MC |
| 1 | Ujungrusi Highway II (Mayor) | 36,98 | 40,42 | 36,98 |
| 2 | Penarukan Road (Minor) | 30,10 | 33,54 | 30,10 |

### 4.3. Side Barriers Analysis

Based on the analysis of the side obstacle survey results, the busiest time at Jalan Raya II Ujungrusi Interchange, Adiwerna District, Tegal Regency, occurs on Mondays between 11:00 am and 12:00 pm. During this period, activities around the road increased, potentially impeding the smooth flow of traffic.

The next step of the analysis was to calculate the weight of the side obstacles, which was done by multiplying each obstacle factor. The weight of the side obstacle factor includes pedestrians with a weight of 0.5, parking or stopping vehicles with a weight of 1.0, vehicles entering and exiting with a weight of 0.7, and slow vehicles with a weight of 0.4.

After the calculation, the total value of side obstacles will be used to evaluate their effect on traffic flow and determine more effective traffic management strategies at the research location.

**Table 7.** Side Barriers

| No | Side Barriers Event Type | Symbol | Factor | Frequences | Weight |
|---|---|---|---|---|---|
| 1 | Pedestrian | PED | 0.5 | 81 | 40.5 |
| 2 | Parking/Vehicle Stopping | PSV | 1 | 157 | 157 |
| 3 | Vehicles Entering and Exiting | EEV | 0.7 | 139 | 97.3 |
| 4 | Slow Vehicle | SMV | 0.4 | 31 | 12.4 |
| Total | | | | | 307.2 |
| Side Barriers Grade | | | | | Medium (M) |

The table analysis shows that on the busiest day, Monday, the side obstacles at Ujungrusi Highway II Interchange were classified as medium, with 300-499 occurrences per hour. These obstacles are dominated by parked or stopped vehicles, as well as vehicles entering and exiting the intersection area. Pedestrians, road crossers, and slow vehicles also contribute. These factors affect the smooth flow of traffic, so handling strategies are needed to improve efficiency.

### 4.4. Intersection Capacity Analysis

The capacity analysis of Jalan Raya II Ujungrusi Triple Intersection aims to assess the maximum capacity of traffic. This capacity is expressed in smp/h and is calculated by considering the base capacity as well as adjusting factors, such as side barriers, public transportation, and traffic conditions. The results of the analysis provide an overview of the intersection's performance and the need for capacity improvements if necessary.

**Table 8.** Intersection Capacity

| Base Intersection Capacity | Adjustment Factor | | | | | | | Intersection Capacity |
|---|---|---|---|---|---|---|---|---|
| | Average Width | Median Type | City Size | Side Barriers | LT Ratio | RT Ratio | Minor Ratio | |
| CO | FLP | FM | FUK | FHS | FBKI | FBKA | FRMI | C |
| 2700 | 1.015 | 1.00 | 1.00 | 0.85 | 1.329 | 0.801 | 0.926 | 2294.52 |

Based on the table above, what is obtained after the field survey and calculation at the Tiga Jalan Raya II Ujungrusi Intersection located in Adiwerna District, Tegal Regency has a traffic intersection capacity (C) of 2294.52 pcu/hour.

### 4.5. Intersection Performance

The intersection performance analysis at Ujungrusi Highway II Triple Intersection located in Adiwerna Subdistrict, Tegal Regency, aims to evaluate the ability of an intersection to accommodate the traffic flow through it, both in terms of capacity, efficiency, and level of service. This analysis aims to provide a comprehensive picture of intersection performance based on traffic flow data, geometric conditions, and the type of traffic control applied. For the calculation of the Ujungrusi Highway II Triple Intersection located in Adiwerna District, Tegal Regency with the following calculation analysis:

a. Degree of Saturation (DS)

$$DS = \frac{2719}{2294.54} = \mathbf{1.185}$$

The degree of saturation calculation shows that the traffic volume at the intersection has exceeded the threshold of 0.8 or the capacity of the intersection itself. Therefore, it is necessary to implement effective traffic management to address this issue.

b. Delay (D)

1) Average Traffic Delay for All Intersections (DTi) For DS > 0.6

$$DTi = \frac{[1.0504]}{(0.2742 - (0.2042 \times 1.185))} - [(1 - 1.185) \times 2]$$

$$DTi = \mathbf{32.97\ s/pcu}$$

2) Average Traffic Delay for Major Roads (DTMA) For DS > 0.6

$$DTMA = \frac{[1.05034]}{(0.364 - (0.246 \times 1.185))} - [(1 - 1.185) \times 2]$$

$$DTMA = \mathbf{19.61\ s/pcu}$$

3) Average Traffic Delay for Minor Roads (DTMI) For DS > 0.6

$$DTMI = \frac{[(2719 \times 32.97) - (1813 \times 19.61)]}{906}$$

$$DTMI = \mathbf{59.70\ s/pcu}$$

4) Intersection Geometry Delay (DG) For DS ≥ 1.0: DG

$$DG = \mathbf{4\ s/pcu}$$

5) Delay (D)

$$D = 4 + 32{,}97$$

$$D = \mathbf{36.97\ s/pcu}$$

c. Queuing Opportunity

In determining the value of queuing opportunities, you can use a formula that refers to the MKJI 1997 method as follows:

Upper limit :

$$PA = 47.71 \times 1.185 - 24.68 \times 1.1852 + 56.47 \times 1.1853 = \mathbf{115.85}$$

Lower limit :

$$PB = 9.02 \times 1.185 + 20.66 \times 1.1852 + 10.49 \times 1.1853 = \mathbf{57.16}$$

d. Level of Services

The level of service of a road reflects the extent to which a road can perform its function well in serving traffic flow. Level of service analysis is conducted to evaluate road performance and determine its operational category. Based on the results of the analysis at the Ujungrusi Highway II Triple Intersection, Adiwerna Subdistrict, Tegal Regency, it is known that the intersection delay (D) value reaches 36.97 seconds per unit passenger car (smp).

Referring to the indicator of road service level based on delay, this value is categorized in level D, which is in the range of 25.1 - 40 seconds /pcu, which indicates less than optimal conditions. At this level of service, traffic flow is close to unstable conditions with high vehicle volumes and minimum speeds of around 50 km/h.

### 4.6. Congestion Level Analysis

Based on the analysis, traffic congestion at Ujungrusi Highway II Triple Intersection, Adiwerna Subdistrict, Tegal Regency, is at a medium level. This is indicated by the degree of saturation (DS) value that exceeds 0.8, indicating very high traffic conditions and approaching the maximum capacity of the road. The level of service at this intersection is categorized in class D, with delay values ranging from 25.1 to 40 seconds per passenger car unit (smp), indicating less than optimal traffic performance.

At this level of service, traffic flow is near unstable, with high vehicle volumes and a minimum speed of about 50 km/h. Traffic density is medium, but traffic density is medium, with a minimum speed of 50 km/h. Traffic density is medium, but fluctuations in vehicle volume and temporary bottlenecks can cause significant speed reductions. In addition, drivers have very limited freedom to control their vehicles, which results in a low level of driving comfort. While these conditions can be tolerated for a short period of time, corrective measures are needed to improve traffic flow and reduce potential congestion at the intersection.

### 4.7. Analysis of Alternative Methods to Solve Congestion

After knowing the traffic problems with the results of the analysis that has been taken into account, then the application of alternative methods to improve performance at the Intersection of Highway II Ujungrusi located in Adiwerna District Tegal Regency. The method in question is a way or action in improving road performance with a variety of alternatives according to the conditions and problems at the location that has been known.

Alternative methods that can be implemented to improve the performance of the intersection at Intersection Three Jalan Raya II Ujungrusi located in Adiwerna District Tegal Regency can be done in the following ways:

a. Road Condition Improvement
b. Handling Side Obstacles
c. Implementation of Signalized Intersection

## 5. Conclusion

Side barrier at the Ujungrusi Highway II Triple Intersection located in Adiwerna District are classified in the medium side obstacle class (M) with a total incidence of 300 - 400 per hour on the busiest day, namely Monday and are influenced by parking / stopping vehicles, then vehicles entering and exiting, followed by pedestrian activity or crossing the road, and slow vehicles.

The results of the intersection performance analysis at the Ujungrusi Highway II Triple Intersection located in Adiwerna District, Tegal Regency showed a high traffic flow with a magnitude of 2719 smp / hour, exceeding the actual intersection capacity of only 2294 smp / hour. With these conditions known to have a degree of saturation of 1.185 which exceeds the threshold of 0.8 or the capacity of the intersection itself, the value of the intersection delay of 36.97 seconds /mp makes the condition of the intersection experiencing traffic congestion, decreased travel efficiency and road user comfort. Then it is known that the value of queuing opportunities in the range of 57.16% - 115.85% is categorized that the level of service (LoS) is at level D (25.1 - 40 seconds /pcu) or in the less category.

The level of congestion at Ujungrusi Highway II Triple Intersection, Adiwerna Subdistrict, Tegal Regency, is in the medium category, with a degree of saturation (DS) exceeding 0.8, indicating very heavy traffic conditions. The level of service at this intersection is classified in category D, with delay values ranging from 25.1 to 40 seconds per passenger car unit (smp), indicating traffic flow that is close to unstable. Under these conditions, vehicle volumes are quite high with minimum speeds of around 50 km/h. Although the traffic density is moderate, fluctuations in vehicle volume and temporary obstacles can cause a significant drop in speed. The driver's space becomes very limited, resulting in a decrease in driving comfort. However, while this situation is less than ideal, it can still be tolerated for a period of time.

Alternative methods that can be applied to overcome congestion at the Ujungrusi Highway II Triple Intersection, which is located in Adiwerna District, Tegal Regency can be implemented in alternative ways to improve intersection performance such as:

a. Road upgrades, especially on minor roads due to the small size or narrowness of the road, can accommodate larger traffic volumes and reduce congestion when delays occur due to the entry of vehicles from major roads or main roads.
b. rearrangement of traffic lanes on the intersection approach can also be an alternative. Such as providing sidewalks or sidewalks for disabled-friendly pedestrians.
c. Then handling side obstacles caused by shops, kiosks or restaurants because they make vehicles park / stop on the shoulder of the road when buying and selling transactions. So it is necessary to control these vehicles and socialize with shop owners to provide parking lots.
d. Another alternative is to implement a signalized intersection because this analysis shows that the intersection has a degree of saturation (DS) >0.8 which indicates very high traffic conditions. The intersection delay value (D) is 36.97 seconds /mp with reference to the road service level indicator based on delay, then the value is categorized in level D (25.1 - 40 seconds /mp) or in a less category and the opportunity for large queues between the value range of 57.16% - 115.85%. As well as the geometric condition of the road that has an incline or descent makes the main factor of congestion and further analysis needs to be done when a signalized intersection is applied at the Ujungrusi Highway II Triple Intersection, which is located in Adiwerna District, Tegal Regency.

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