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ABSTRACT

Traffic problems we often encounter in various cities in Indonesia. This is due to the increasing volume of vehicles that are affected by population growth and economic growth, while the road capacity tends to remain constant. The city of Semarang is one of the cities with a heavy traffic movement of people, goods and services that has a high level of traffic density. One of them is the intersection of the jatingaleh highway, which is the meeting point of traffic flows from various directions which are very crowded every day in the peak hours of morning (06.00-08.00 WIB) and afternoon (16.00-18.00 WIB). This study aims to solve the congestion on Jalan Jatingaleh by applying uneven intersection efficiency, namely Fly Over, Underpass and a combination of Fly Over-Underpass. This Flyover model is combined with transportation management so that it can overcome congestion, a sense of security and comfort for the road user community.

KEYWORDS: Fly Over Model, Congestion, Transportation Management

1. INTRODUCTION

The city of Semarang is one of the cities with the movement of traffic both human, goods and services that have a high level of traffic density. One of them is the Jatingaleh Highway which connects the southern Semarang area with other areas. Congestion on Semarang's Jatingaleh road was triggered because of the many intersections that existed, among others at the Kesatrian intersection, the PLN intersection, and the Jatingaleh market intersection as well as the non-functioning Traffic Lamp. The impact of the congestion includes loss of time, economy and environment. Automatically, this negative impact in terms of time also has an economic impact, where waste of fuel is wasted due to the vehicle running below optimum speed or stopping frequently. Besides that, tires can wear out faster because vehicles are too often braked. Another impact is on the environment in the form of increased air pollution due to CO [1]. The aims of this study was conducted to solve congestion problems on the Jatingaleh Road by using a model of Fly Over, Underpass or Combination of Fly Over-Underpass combined with transportation management to provide a sense of security, comfortable to the road user community at the intersection of Jalan Setia Budi - Jalan Teuku Umar Jatingaleh Semarang.

2. MATERIALS AND METHODS

The aims of this study is to produce a transportation management based Fly Over model to overcome congestion at a crossroads [2]. To realize these results done steps as follows :

1. Identification of road and traffic characteristics..
2. Congestion analysis based on transportation management.
3. Reviewing Fly Over Mode and other road models such as Underpass, U-Turn Fly Over and Overpass.
4. Implementing the modeling results by creating Prototype.

The data used in this study are primary data and secondary data. Primary data is data obtained from field observations, while secondary data is data obtained from relevant agencies that support primary data.

2.1 Primary Data

Primary data of Jalan Setia Budi - Jalan Teuku Umar as follows:

1. Characteristics of traffic flow:

This data is obtained from observations in the field, by calculating the number of vehicles passing Teuku Umar Road- Setia Budi Road in the peak hours of morning and evening. Types of vehicles that are calculated and grouped in several types of vehicles, such as:

a) Heavy Vehicle / HV, :

This type of vehicle includes: buses, trucks and other heavy vehicles.

b) Light Vehicle / LV,

This type of vehicle includes: public transportation, medium buses, pick ups, private cars and other light vehicles.

c) Motor Cycle / MC

The purpose of this data collection is to determine the number of each type of vehicle entering and leaving the research location. This calculation is carried out using the short break counting method, where the calculation of the number of vehicles is carried out every 5 minutes up to 5 minutes 12 (for 1 hour during peak hours). This is used to determine the graph of traffic flow that occurs for 1 hour and as a correction factor for accuracy in observation.

1. Inventory of road geometric data

2. Side barriers

2.2 Secondary Data

These secondary data come from statistical data issued by the government or research institutions and also publications or related study reports relating to the study of research objects, for example population data, motorized vehicle data, and non-motorized vehicles.

3. RESULTS AND DISCUSSION

3.1 Traffic Volume

Based on the analysis of road functions along Teuku Umar Road - Setia Budi Road including Arterial roads. At peak hours the traffic volume is quite dense, causing a delay in traffic flow. To obtain primary data in this study, the number of vehicles was calculated manually using the Short Break Counting method according to each type of vehicle. This calculation is done by calculating every 15 minutes. The number of vehicles counted comes from two directions, both in the direction of Setia Budi Road - Teuku Umar Road and vice versa.[3]

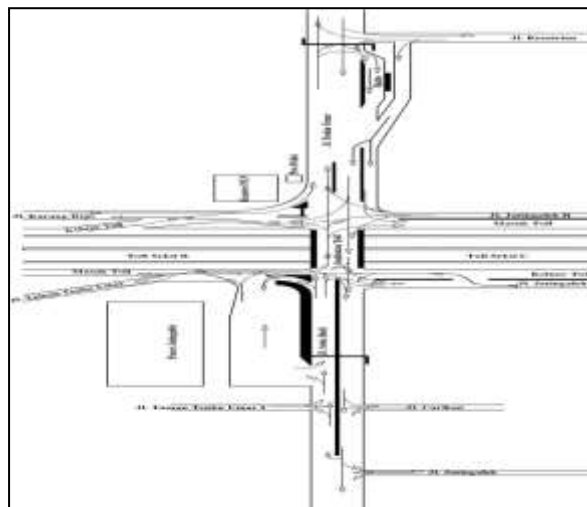


Figure 1. Conditions of Movement Patterns of Jatingaleh Junction

2.2 Transportation Type

The modes of transportation that pass on this road are very diverse in the form of public transportation, city transportation, freight transport and private vehicles. Vehicles in the peak hours of the morning (06.00 - 08.00 WIB) and afternoon (16.00 - 18.00 WIB) are like the diagram below :

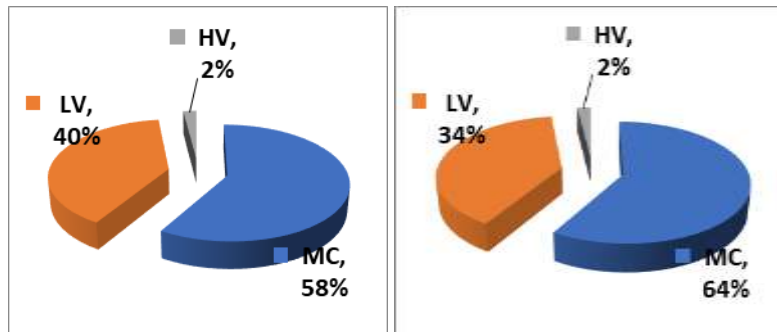


Figure 2. Vehicle type composition diagram

In Figure 2 composition diagram of the type of vehicle above, you can see the most dominant type of vehicle that passes along Jalan Teuku Umar - Jalan Setia Budi is a motorcycle (MC), with the percentage in the morning 64% and afternoon 58%.

2.3 Geometric Identification of Roads

To find out the geometric conditions of the Teuku Umar Road - Jalan Setia Budi road researchers conducted observations and measurements directly in the study area, namely from the front of the tax office to the Kesatrian intersection in order to obtain data on traffic lane width, road median, road shoulder, sidewalk, etc. [4]. Observation results are as follows:

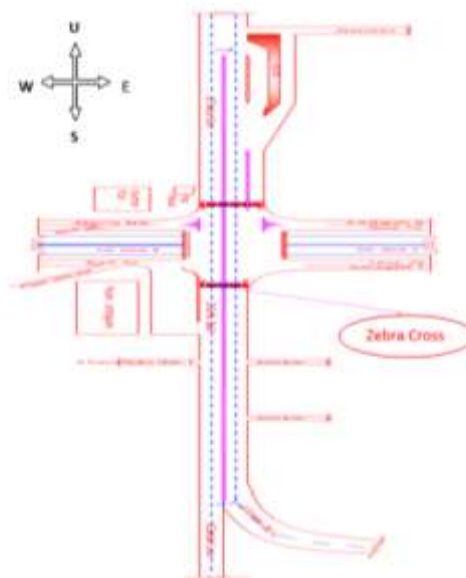


Figure 3. Geometry of Semarang Jatingaleh Road Looks From Top

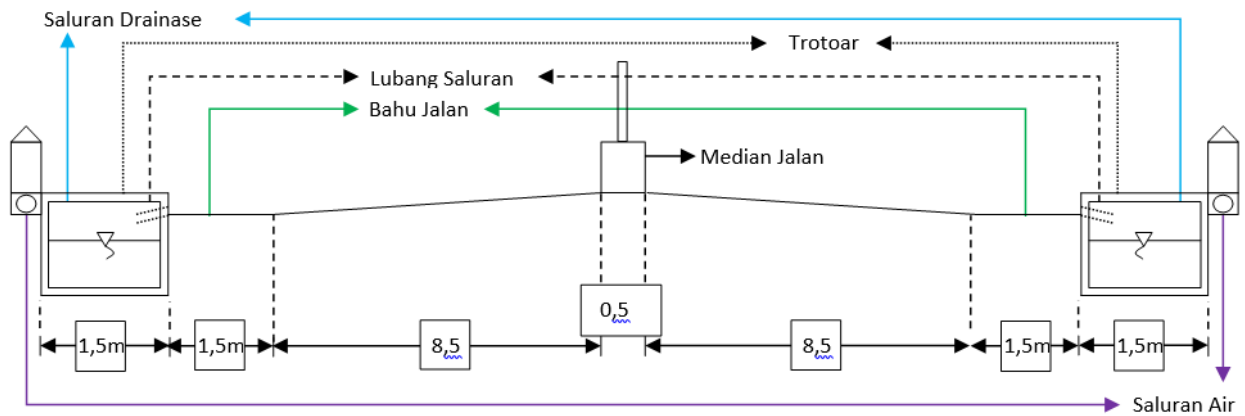


Figure 4. Geometric Cross section of Jatingaleh Street Semarang

Table 1. Geometric Information on Semarang Jatingaleh Main Road

No	Mayor Road	Width of The Road	Slackness
A	PLN Office - Kesatrian intersection	4/2 D median = 0,5 m road = 2x8,5 m	slightly uphill with slump > 3%
B	Tax office - Jatingaleh Market	4/2 D median = 0,5 m (only in front of the market) road = 2x8,5 m	slightly uphill with slump > 3%
C	Jatingaleh Market - PLN Office	4/2 D road = 2x8,5 m	slightly uphill with slump < 3%

*)Source : Analysis Result

2.4 Identification of Road Interchange

In the study area there were 3 (three) intersections, namely:

1. Jatingaleh Crossroads (between Setia Budi road – Toll Bridge)

This intersection is a meeting of traffic flow between Major road (from the direction of Setia Budi road – Teuku Umar road), with Mino road (from the direction of Taman Teuku Umar road / Entrance Toll Section B and Jatingaleh I / Exit Toll Section C).

2. Crossroad PLN (Toll Bridge - Teuku Umar road)

This intersection is a meeting of traffic flow between Mayor (from the direction of Setia Budi road - Teuku Umar road), with Minor road (from the direction of Karangrejo road / Exit Toll Section B and Jatingaleh road II / Entrance Toll Section C).

3. Kesatrian Intersection (between Teuku Umar road – Kesatrian road)

This intersection is a meeting of traffic flow between Mayor road (from Teuku Umar road), with Minor road (from the direction of Kesatrian road).

2.5 Condition of Complementary Facilities for Roads on Teuku Umar Road - Setia Budi road

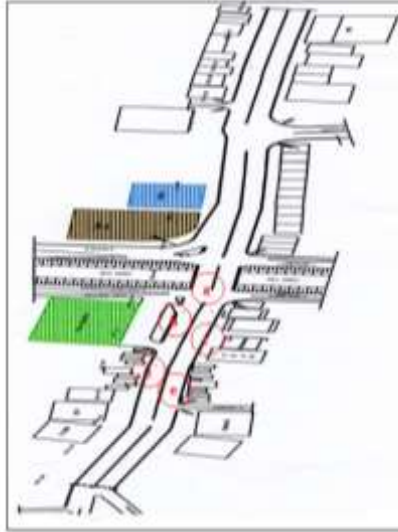


Figure 5. Geometric condition of Semarang Jatingaleh road

2.6 Congestion on Unsignalized Deviation

This identification begins to observe the location that is prone to delay/congestion as the interrelated axes in the study area. The following are locations that have the potential to become congestion hubs based on observations in the study area.

Based on the conditions in Figure 4.9 below, it can be observed that where the location of delays / congestion occurs at 3 unsigned intersection nodes, namely the Kesatrian intersection, the PLN intersection, and the Jatingaleh intersection.

Several factors that cause of the unsigned intersections



delays / congestion in each are as follows:

Figure 6. Location of Congestion Conflict Points

2.7 Analysis of unsignalized intersection

The methods and procedures used to analyze the performance measures of the unsignalized intersection according to MKJI, 1997 are:

A. Capacity

The total capacity for all intersections is the result of multiplication between basic capacity (C_0), namely the capacity at certain conditions (ideal) and adjustment factors (F) by taking into account the influence of field conditions on capacity, according to (MKJI 1997) as follows:

B. Degree of saturation

Calculation of the degree of saturation at the intersection location can be seen in the appendix, the shorter the results of the degree of saturation (DS) for each intersection are presented in the table below:

Table 2. Analysis of Degree of Saturation at Jatingaleh Road Junction

Junction	DS Value (Morning)	DS Value (Afternoon)
Kesatrian	1,58	1,35
PLN	1,86	2,06
Jatingaleh	1,56	1,41

Source : Analysis Result

From the results of the analysis that has been carried out, the degree of saturation at each intersection of Semarang's jatingaleh road in the morning and evening (Peak Hour) on average is > 1.00 (more than one).

2.8 Planning a Fly Over, Underpass, and Combination Over-Underpass Model.

Jatingaleh Road Semarang is a road with heavy traffic flow especially during rush hour, along Teuku Umar road - Setia Budi road there are 3 unsignalized intersections, namely kesatrian intersection, PLN, and Jatingaleh. Vehicles that cross the Jatingaleh road area are varied.

3.8.1 Analysis of Fly Over Model

The planned Fly Over model has a length of approximately 620 m and a width of each 7 m line with a median on the Fly Over and median on the existing intersection road. The goal is to eliminate crossing and weaving currents that cause congestion.



Figure 7. Jatingaleh Fly Over 3D Design

3.8.2 Capacity Analysis of the Underpass Model

The purpose of the capacity analysis of the Underpass model is to determine the volume capacity of the plan that can be accommodated by the Underpass later, both the Underpass which is at the Kesatrian intersection and the Jatingaleh intersection.

1. Underpass Sin



Figure 8. Underpass Kesatrian Intersection 3D Design

Underpass roads planned at two points, namely those at the intersection of intersection and jatingaleh intersections are 2-lane roads with a traffic lane width of 6 m, from MKJI, 1997 obtained:

Underpass roads planned at two points, namely those at the intersection of intersection and jatingaleh intersections are 2-lane roads with a traffic lane width of 6 m, from MKJI, 1997 obtained:

- Co : 1650 (cpu/hour/lane)
- FCw : 0.87 (Wc per lane 3.0 m)
- FCSP : 1 (road 2 lane, wide 6m)
- FCSF : 0.94 (side bar resistance L, distance curb-barrier $W_k \leq 0.5m$)
- FCCS : 1.00 (city size 1.0 - 3.0 million inhabitants)

With these values, the capacity of the Setia Budi Underpass planning - Jalan Teuku Umar will be obtained as follows:

$$\begin{aligned}
 C &= 1650 \times 0.87 \times 1.00 \times 0.94 \times 1 \\
 &= 1349 \text{ cpu/hour/lane} \\
 &= 2698 \text{ cpu/hour (for 2 lanes)}
 \end{aligned}$$

2. Intersection

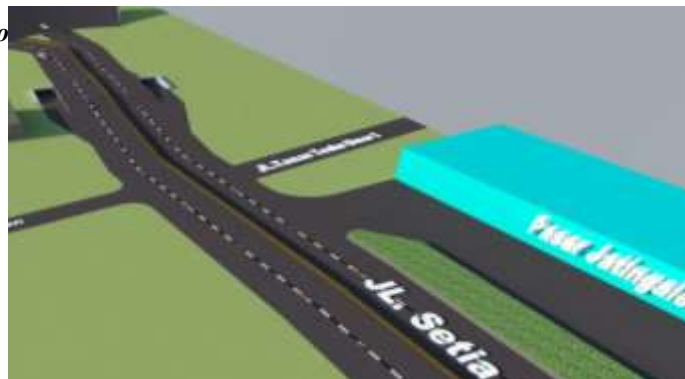


Figure 9. 3D Design of Jatingaleh Underpass

Source : Analysis Result

Underpass has been planed into two point there are in Kesatrian intersection and Jatingaleh intersection which is have 2 lane with its width 6m, from MKJI, 1997 :

- Co : 1650 (smp/hour/lane)
- FCw : 0.87 (Wc per lane 3.0 m)
- FCSP : 1 (2 lane, width 6m)

FCSF : 0.94 (class of side barriers L, kerb distance– barrier $W_k \leq 0.5m$)

FCCS : 1.00 (ukuran kota 1.0 – 3.0 juta penduduk)

From the data of MKJI the capacity of Underpass Setia Budi Road – Teuku Umar road can be calculated :

$$C = 1650 \times 0.87 \times 1.00 \times 0.94 \times 1$$

$$= 1349 \text{ smp/hour/lane}$$

$$= 2698 \text{ smp/hour (for 2 lane)}$$

2.9 Analysis of Fly Over-Underpass Model Combination

According to vehicle density and traffic flow conflict that happened in intersection of Jatingaleh Road, in order to overcome the congestion that happened in that road the solutions are increase road capacity and make a new road for a long period is good enough if the two solutions can be combined, which is make a Fly Over-Underpass as the solution in order to reduce the traffic flow conflict like Crossing and Weaving in Intersection of Jatingaleh Road which is segmented into Kesatrian intersection, PLN intersection, and Jatingaleh intersection. Combination of Fly Over-Underpass that has been designed the concept is just the same with the underpass before which has width 6m without median, 5m tunnel height and give a median along Jatingaleh road. But for the tunnel height of the Combination of Fly Over-Underpass divided into 2 which is 2,5 m elevated over the existing road (Fly Over) and 2,5 bellow the existing road (Underpass).



Figure 10. 3D Design of Fly Over-Underpass Combination Jatingaleh Road

Source : Analysis Result

A. Calculation of Flow Reduction on *Fly Over-Underpass*

As the steps that have been taken in the previous sub-section and the calculation of flow reduction analysis in the Appendix, the data are presented as follows.

Table 3. Calculation of Flow Reduction on *Fly Over-Underpass*

Movement Direction	smp/hour
Morning Underpass	1247
Evening Underpass	723
Total	2784

Source: Analysis Result

B. Reduction of Total Flow after Combination of *Fly Over-Underpass*

Reduction of Total Flow after Combination of *Fly Over-Underpass* can be seen and analyze from the movement pattern that happened in Jatingaleh Road Area from the traffic flow condition. To Compare the traffic flow volume condition, the data shown on **Table 4.** :

Table 4. Comparison of Traffic Condition before and after combination of Fly Over-Underpass

Specification	Time	Before Underpass constructed	After Underpass Constructed
Volume	Morning	4733 (smp/hour)	1247(smp/hour)
	Evening	4258 (smp/hour)	723(smp/hour)
DS	Morning	1,03	0,46
	Evening	0,93	0,40

From **Table 4.14** above the results of the comparison of traffic flow conditions are the same as the previous underpass model, because the composition of the road from Fly Over-Underpass Combination model with the basic Underpass model is the same, the only difference is the tunnel height.

1. CONCLUSION

From the analyze can be concluded :

1. Combination of the shape of Fly Over- Underpass can reduce the flow until 26,35%. Beside that the asumstion of traffic flow is 2,92% every year, the traffic flow that can be served predicted when Fly Over and Underpass combined is 17 year
2. Combination of Fly Over model which is multifunction and exact can reduce the congestion and remove the conflict point caused of crossing and Weaving in Jatingaleh intersection.
3. The amount of delay reduction before and after the combination of Over-Underpass Fly is 1.56 (morning) and 1.41 (afternoon) before the combination of Over-Underpass Fly and reduced by 0.46 (morning) and 0.40 (afternoon) after the combination of Over-Underpass Fly indicates a loss in terms of time, economy and environment can be reduced, because of the eloquent flow of traffic without delay.
4. With the congestion conflict in 324 intersection (3 pendekat, 2 lajur minor dan 4 lajur utama) simpang Kesatrian dan persimpangan 424 (4 pendekat, 2 minor lane dan 4 main lane) PLN intersection with Jatingaleh intersection can be overcome with Fly Over-Underpass Combination Model.
5. Policies of Transportation System in Semarang to overcome the congestion are :
 - a. Law Enforcement System
 - b. Establishment of the Mass Transportation Management Agency
 - c. Special Budget Preparation

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