Transportation modelling using PTV Vissim for the adjacent junction in Sampangan Semarang City

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Abstract. The growth of vehicles in the city of Semarang is fast, as calculated based on the BPS Semarang the number of vehicle growth is 11% per year. This causes the road capacity to be periodically increased. As is the case at the adjacent intersections on Dewi Sartika street and Talangsari street initially, to break up delays and queues and increase capacity, efforts were made to add a 7-meter-wide bridge. However, this widening will not solve the problem in the next 5 years so that alternative solutions are needed for the two intersections. This study aims to evaluate the two intersections using the Binamarga method based on the 1993 MKJI, to determine the capacity of the intersection and plan the design of the intersection in the future and then make modelling with PTV Vissim Software to describe the simulation of the actual situation.

1. Introduction
Mobilizing human life is inevitable. As time goes by, the need to travel from one place to another is very high. Mobilizing systems operate in a domain that is anything but simple [1]. Vehicles are issuing that people must consider when the acceleration of the process of social industrialization [2]. Therefore, we need a means of transportation that can reach the trip. Transportation is an important tool to meet demands and goals in today's society because transportation is a unified system of facilities and infrastructure [3]. Smooth traffic is not only needed in big cities, suburbs and rural areas also need it.

The progress of the development of mobilization in the city of Semarang resulted in very rapid road construction, which in turn resulted in higher mobilization and traffic flow in the city of Semarang. If this is not accompanied by a good traffic policy or the implementation of a good traffic system, it can cause queues on the highway and even traffic accidents [4]. Crossroads are the main areas where roads meet, therefore due to the meeting of the two roads or highways, there are conflict points and it is easy to avoid this, it is necessary to make arrangements at the intersection [5]. The intersection arrangement also serves to minimize delays and increase the capacity of the intersection.

In the case of Dewi Sartika Raya Street, there is an adjacent intersection where the road between the two intersections is very short less than 500 meters causing queues to occur easily [6]. This is due to the increasing volume of vehicles from year to year to the low level of awareness of motorists to obey traffic. Previously, the two intersections were unsignalized intersections which then intersect at one of these intersections on Dewi Sartika Raya Street – Dewi Sartika Timur Street – Dewi Sartika Barat Street was
given an APILL (Traffic Signaling Tool) in the form of a traffic light. However, APILL only provides a temporary solution to the intersection so that the intersection on Dewi Sartika Street - Talangsari Street queues still occur because the intersection does not yet have a signal.

The 1997 Indonesian Road Capacity Manual (MKJI) will be used to analyse adjacent intersections on Dewi Sartika Street where the parameters used to examine are vehicle volume, speed, queue length, delay, degree of saturation for signalized intersections, and unsignalized intersections using parameters of delay, degree of saturation and queue opportunities [5]. This study does not only analyse the 1997 MKJI method, there is also VISSIM modeling to coordinate between intersections with parameters of a degree of saturation, delay, travel time, and level of service.

1.1. Transportation
Transportation is the process of moving or transporting people, animals, and goods from one place to another by using a means of transportation. As for those who say that transportation is the transfer of people or goods from one place to another by using a vehicle driven by humans or machines. Transportation is used by humans to facilitate their daily activities. Most of the daily human activities are related to the use of means of transportation. With these means of transportation, it is easier for humans to move or move goods to certain destinations. Identification and quantification of traffic congestion are crucial for decision-makers to initiate mitigation strategies to improve the overall transportation system’s sustainability [7].

1.2. Transport Modelling
Modelling can be defined as a simple form of reality or the actual world, including:
   a. Physical model (architect model, civil engineering model, etc.).
   b. Statistical and mathematical models (equations) that explain some aspects of physical, socio-economic, and transportation models.
   c. Maps and diagrams (graphics).
   d. These models are a form of simplification of reality to achieve certain goals, such as to represent a condition, and forecasting and understanding [8,9].

1.3. Intersection
An intersection is a meeting between two road sections on the same or non-level lines, the intersection is a location where accidents often occur due to the movement of opposing vehicles (PP Number 43 of 1993). Conflicts that often occur at unsignalized intersections are queues caused by the system "giving in to each other" so that what happens to signalled and unsignalled adjacent intersections is the irregularity of drivers, causing delays and queues. At the intersection there are 4 basic types of vehicle movement, namely diverging, merging, crossing, and weaving [10,11,12].

1.4. PTV VISSIM Software
PTV VISSIM is a program used for 3-D modelling of traffic flow with various types of vehicles [13]. VISSIM is a useful tool for modelling traffic flows, including cars, motorcycles, freight transport, buses, to pedestrians. In VISSIM, the types of vehicles that can be modelled include vehicles (cars, buses, trucks), public transport (trams, buses), cycles (bicycles, motorcycles), pedestrians, and rickshaws [4]. Developing a simulation model using VISSIM requires a series of information on the transportation network to be simulated and modelled.

2. Result and Discussion
Based on the results of research and modelling using Vissim PTV Software, the following results are obtained:
Vissim software has an output in the form of LOS (Level of Service), the results of the output are as follows (table 1):
Table 1. LOS VISSIM for Initial Intersection and After Improvements

| Vehicle Peak Time | Intersection Parts | LOS VISSIM |
|-------------------|--------------------|------------|
| Morning (8.30 am – 9.30 am) | A | LOS F |
| Afternoon (3.45 pm – 4.45 pm) | B | LOS F |

| Vehicle Peak Time | Intersection Parts | LOS VISSIM |
|-------------------|--------------------|------------|
| Morning (8.30 am – 9.30 am) | A | LOS D |
| Afternoon (3.45 pm – 4.45 pm) | B | LOS C |

Based on these results, an evaluation was carried out using MKJI 1997 using the results of traffic counting in the field at two peak hours of vehicles in the morning peak hours, namely at 08.30 - 09.30, while the afternoon peak hours at 15.45 - 16.45 were obtained the volume of the original intersection vehicle at the peak hour in the morning 1312 vehicles/hour and at peak hour afternoon 1582.5 vehicles/hour.

From the results of the volume of the vehicle then it is calculated at the degree of saturation of the original intersection which has the following results (table 2):

Table 2. Degree of Saturation Initial Intersection

| Vehicle Peak Time | Intersection Parts | Degree Of Saturation |
|-------------------|--------------------|----------------------|
| Morning (8.30 am – 9.30 am) | A | 0.94 |
| Afternoon (3.45 pm – 4.45 pm) | B | 0.87 |

The existing condition of the intersection undergoes a geometric change in the form of road widening which aims to increase the capacity of the intersection. From the improvements, the degree of saturation of the intersection is generated as follows (table 3):

Table 3. Degree of Saturation Intersection After Improvements

| Vehicle Peak Time | Intersection Parts | Degree Of Saturation |
|-------------------|--------------------|----------------------|
| Morning (8.30 am – 9.30 am) | A | 0.86 |
| Afternoon (3.45 pm – 4.45 pm) | B | 0.93 |

To predict traffic conditions in the next 5 years, using the results of the original vehicle volume and calculating vehicle predictions in the next 5 years with the Semarang City vehicle growth rate which
amounted to 11% per year, the volume of vehicles for 5 years in the morning peak time was 2222.75 vehicles/hour and the afternoon peak time is 2679.978 vehicles/hour.

The prediction results were then calculated on the LOS Vissim and the degree of saturation with the following results (table 4):

**Table 4. Degree of Saturation Intersection After Improvements in 5 Years**

| Vehicle Peak Time                  | Intersection Parts | Degree Of Saturation |
|-----------------------------------|--------------------|----------------------|
| Morning (8.30 am – 9.30 am)       | A                  | 1.09                 |
| Afternoon (3.45 pm – 4.45 pm)     |                    | 1.30                 |
| Morning (8.30 am – 9.30 am)       | B                  | 1.21                 |
| Afternoon (3.45 pm – 4.45 pm)     |                    | 1.23                 |

Based on the evaluation results from the simulation and the 1997 MKJI, it was found that the degree of saturation did not meet the maximum standard of 0.8 and the LOS level was very low so that the road did not meet the standards of the Minister of Transportation Regulation KM 14 of 2006 [14]. Alternative solutions are needed to connect the two intersections to increase capacity to meet standards and overcome the problems that exist at both intersections [15].

a. The first solution is widening the road to increase the capacity of the intersection
b. The second solution is a canal red light that is connected between the two intersections to break up queues and delays at Simpang B and restore the naturalness of the intersection which has been affected by the intervention of the illegal traffic controller "Pak Ogah".

From the results of the two intersection solutions (first solution in table 5 and second solution in table 6), the results of the degree of saturation and the optimal LOS are obtained as follows:

**Table 5. First Solution for Adjacent Intersection**

| Intersection Parts | Level Of Service | Degree Of Saturation |
|--------------------|------------------|----------------------|
| A                  | LOS C            | 0.81                 |
| A                  | LOS C            | 0.84                 |
| B                  | LOS C            | 0.88                 |
| B                  | LOS C            | 0.84                 |

**Table 6. Second Solution for Adjacent Intersection**

| Intersection Parts | Level Of Service | Degree Of Saturation |
|--------------------|------------------|----------------------|
| A                  | LOS C            | 0.81                 |
| B                  | LOS C            | 0.83                 |
| A                  | LOS C            | 0.88                 |
| B                  | LOS C            | 0.82                 |
3. Conclusion

The conclusion of the Transportation Modelling Using PTV Vissim For Adjacent Junction are as follows:

1. Based on both solution for the adjacent intersection, turns out the second option is the most effective to solve the problem on both intersections. Because in the long term the existence of “Pak Ogah” or the illegal traffic controller will affect the flow of the traffic it can cause several problems, for example, unwanted queue or even stop delay.

2. Somehow, MKJI 1997 is not related anymore to future planning. It needs several changes on a few parameters.

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