The Effect of Increasing Vehicle Volume on Some Roads in Surabaya Post Pandemic

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Abstract
Population growth and economic development in Indonesia affect the increase in the volume of vehicles. In the era of the pandemic, Indonesia's population growth has increased, so the need for vehicles also increases. The increase in the volume of vehicles, causes congestion in various areas. The WFH (Work From Home) policy, due to the Covid-19 pandemic, has reduced the use of vehicles in traffic. Two years after the pandemic, in 2022, the volume of vehicles in traffic will be higher due to activities that have started to return to normal. The abolition of the WFH (Work From Home) policy has resulted in school offices, tourist attractions, and other infrastructure making the activities of the Indonesian people and economy rise slowly. Although the economy in Indonesia has not increased significantly or can be called unstable, the purchasing power of motorized vehicles has increased. From the results of the research carried out above, it is known that the capacity of Darmo road and Pemuda road has increased the DS value (degree of saturation) in the post-pandemic period compared to the pandemic conditions during the PSBB period. The increasing community activities caused the increased DS value (degree of saturation). This resulted in traffic on Jalan Darmo, Pemuda, and Ahmad Yani becoming more congested than during the pandemic.

Keywords: vehicle, traffic, pandemic

INTRODUCTION
Covid-19 is an infectious disease caused by SARS-CoV-2 [1][2]. From 2019 to 2021, there was a global coronavirus pandemic around the world [3][4][5]. This disease first appeared in Wuhan, China, in December 2019. There are about 200 countries in the world, including Indonesia, that have been affected by the virus that is shaking the international community [6][7]. Governments around the world have made various efforts to prevent the spread of Covid-19, such as social distancing and lockdowns from preventing the spread of the Covid-19 virus [8][9][10].

The increase in the intensity of movement that leads to increased direct access to the city center is driven by population growth and an increase in motorized vehicles[11][12]. This increasingly rapid population growth can also lead to increased demand for access to transportation modes with large capacities [13][14].

As a result of the increasing number of motorized vehicles, urban traffic has become more congested, causing traffic jams [15][16][17]. Usually, congestion will arise at intersections and pedestrian crossing areas [18]. Traffic jams that usually occur need to be handled so as not to cause problems or other losses.

RESEARCH METHODS
This journal uses a qualitative descriptive research type. Data collection is a method used to collect information or facts obtained that need to be done after a topic is discussed and accepted [19][20].

Primary data is data obtained from pre-existing journals. Side resistance and degree of saturation are preliminary data for road capacity. Secondary data is data that supports the collection of primary data. Data collection steps:
1. Determine the topic to be discussed.
2. Looking for various journal references related to the topics discussed.
3. Collecting data that has been obtained from the journal.
4. Summarize the data that has been collected.

RESULTS AND DISCUSSIONS
Traffic data is required during road planning, design, management, and operation. The peak road volume data for each passing vehicle is adjusted in passenger car units (pcu) for each type of vehicle.

Road Capacity
Road capacity is the flow that exceeds the maximum capacity of a road segment at a particular time [21][22]. The unit of road capacity is the passenger car unit (pcu/hour) using the value of the passenger car.
Road capacity formula:

\[ C = C_0 \times F_{CLJ} \times F_{CPA} \times F_{CHS} \times F_{CUK} \]  

(1)

From the above formula, it can be stated that \( C \) is the road capacity with units of pcu/hour, \( C_0 \) is the essential capacity with units of pcu/hour, \( F_{CLJ} \) is the effective width factor of the lane, \( F_{CPA} \) is the direction separator factor, \( F_{CHS} \) is the side obstacle factor, and \( F_{CUK} \) is the factor city size.

**Side Barriers**

Activities that disrupt the flow of traffic along the highway can be defined as side barriers [23]. Side barriers can be in the form of pedestrian activity, vehicles that stop or park on the shoulder of the road, vehicles coming in and out, and slow-moving vehicles.

**Free Flow Rate (Vf)**

Free Flow Speed is the vehicle’s speed at the zero current level, meaning the vehicle's speed that is not used by other vehicles. Free Flow Speed formula:

\[ V_B = (V_{BD} + V_{BL}) \times F_{VHS} \times F_{VBUK} \]  

(2)

\( V_B \) is the free flow speed for light vehicles in field conditions (km/hour), \( V_{BD} \) is the basic free flow speed for light vehicles, \( V_{BL} \) is the speed adjustment value due to road width (km/hour), \( F_{VHS} \) is the free speed adjustment factor due to side obstacles on roads that have shoulders or roads with curbs/pavements with a curb distance to the nearest barrier, \( F_{VBUK} \) is the independent speed adjustment factor for city size.

**Degree of Saturation**

The ratio of traffic volume to road capacity is called the degree of saturation [24][25]. The degree of saturation (DS) is the ratio of vehicle volume to road capacity. The equation for the degree of saturation is:

\[ DS = \frac{Q}{C} \]  

(3)

The explanation from the above formula is DS, which is the degree of saturation. \( Q \) is the volume of vehicles in units (pcu/hour), and \( C \) is road capacity in units (pcu/hour). If the road is still feasible, then the value of DS < 0.75. If a handler is needed to solve the congestion, the DS value is > 0.75.

**Travel Speed (VT)**

Travel speed (VT) is the vehicle's actual speed, whose amount is determined based on the calculated function of DS and VB. The determination of the VT value is carried out using the diagrams of Figure 1 and table 1 for medium roads and Figure 2 and table 2 for highways or one-way roads.

**Travel Time (WT)**

Travel time (WT) can be known based on the value of VT in taking the analyzed road segment along L. To calculate travel time; can use the formula:

\[ WT = \frac{L}{VT} \]  

(4)

WT is average travel time for light vehicles (hours), \( L \) is segment length (km), VT is light vehicle travel speed or light vehicle space average speed (space mean speed, SMS, (km/hour))

**Analysis of the Capacity of the Darmo Road**

Darmo road is the main road that connects the north and south of Surabaya, which has three lanes per direction with a median that separates the two directions. With high side barriers, the road is 3.6 meters wide per lane. Surabaya is included in the category of very large city size because it has a population of approximately 3.25 million people.

It can be seen that the capacity of the Darmo Road segment, namely the basic capacity (Co) obtained from 3 lanes x 1650 pcu/hour, is 4950 pcu/hour. Then the effective width factor (FC_LJ) with a value of 1.03, the direction separation factor (FC_PA) is 1, and the side resistance factor (FC_HS) is 0.95. city size factor (FC_UK), which is 1. To find the Capacity (C), use the formula:

\[ C = C_0 \times F_{CLJ} \times F_{CPA} \times F_{CHS} \times F_{CUK} \]

\[ C = 4950 \times 1.03 \times 1 \times 0.95 \times 1 \]

From the results of the calculation of the formula, it is found that the capacity is 4844 pcu/hour for 1 direction. For each condition, the value of the degree of saturation (DS) in the Darmo Road area is:

- DS Condition during PSBB = \((2493 \text{ pcu/hour})/(4844 \text{ pcu/hour})\) = 0.51
- DS New Normal Condition = \((2981 \text{ pcu/hour})/(4991 \text{ pcu/hour})\) = 0.597

At the time of PSBB, the peak hour volume on Darmo Road was 2493 pcu/hour with a DS of 0.51. In New Normal conditions, the peak hour volume has increased compared to PSBB conditions, where the increase is 2981 pcu/hour with a DS of 0.597.

To determine the Travel Speed (VT) on the Darmo road using Figure 2 and table 2. The VB value on the Darmo road during PSBB is 80 km/hour with a DS of 0.51, so the VT value is 69 km/hour. Meanwhile, during the new normal, the VB value is 50 km/hour with a DS value of 0.597, and the VT value is 65 km/hour.

Table 1. Ideal VT relationship with DS, on road type 2/22T

<table>
<thead>
<tr>
<th>Ideal VT on road type 2/22T</th>
<th>VT (km/hour)</th>
<th>DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>0.70</td>
<td></td>
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<td>36</td>
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<td>38</td>
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<tr>
<td>40</td>
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</tr>
<tr>
<td>41</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>
Figure 1. VT relationship with DS on road type 2/2T
Figure 1 and Table 1 show the relationship between VT and DS for one-way roads. The Darmo, Pemuda, and Ahmad Yani highways are not one-way streets

Pemuda Road Capacity Analysis

Pemuda Road is a road in downtown Surabaya. This road is a one-way street that has four lanes. The road is 3.5 meters wide on each lane with low side resistance.

The Pemuda Road section can be seen with a basic capacity (Co) of 4 x 1650 pcu/hour, so that it is obtained 6600 pcu/hour, then the effective lane width factor (FC_L) is 1, the direction separation factor (FC_PA) is 1, the obstacle factor is one side (FC_HS) is 0.88, city size factor (FC_UK) is 1.04. So from the data above, we can know the capacity (C) with the formula:

\[ C = \text{Co} \times FC_{LJ} \times FC_{PA} \times FC_{HS} \times FC_{UK} \]

\[ C = 6600 \times 1 \times 1 \times 0.87 \times 1 \]

From the above formula calculation, the capacity value is 5742 pcu/hour.

The value of the degree of saturation (DS) in each condition on the width of the youth road is as follows:

- During PSBB condition: \( DS = \frac{1637 \text{ pcu/hour}}{5742 \text{ pcu/hour}} = 0.285 \)
- New Normal Condition: \( DS = \frac{3134 \text{ pcu/hour}}{5742 \text{ pcu/hour}} = 0.546 \)

During PSBB conditions, the peak hour volume for the Darmo road segment is 1637 pcu/hour with a DS of 0.285. The peak hour volume increased in New Normal conditions compared to conditions during PSBB, which was 3134 pcu/hour and DS was 0.546.

Ahmad Yani Road Capacity Analysis

Ahmad Yani road Surabaya is a two-way central road with a separator that connects the city of Surabaya with Sidoarjo, each of which has three lanes.

The capacity of Ahmad Yani road in 2006 was 4,428 pcu/hour from the direction of Sidoarjo to Surabaya, with an average pavement width of 10.3 meters. The average vehicle flow is 6,511 pcu/hour with DS = 1.301 and is projected to increase to 1,531 in 2010. On the other hand, the capacity from Surabaya, with an average pavement width of 9.70 meters, to Sidoarjo is 4,125 pcu/hour, with traffic volume averaging 5,425 pcu/hour, DS=1.431 and expected to reach 1,591 in 2010.

In the traffic flow on Jalan Ahmad Yani, both from Sidoarjo to Surabaya and the other way around, congestion often occurs, especially during peak hours and weekdays. The value of the degree of saturation in each direction of the road is 1.301 and 1.431 which is far from the threshold (DS = 1.0).

Table 2. Ideal VT relationship with DS, on road type 4/2T, 6/2 T

<table>
<thead>
<tr>
<th>Ideal VT on road type 4/2T, 6/2 T</th>
<th>DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>VT 35</td>
<td>1.00</td>
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<tr>
<td>VT 45</td>
<td>0.90</td>
</tr>
<tr>
<td>VT 49</td>
<td>0.80</td>
</tr>
<tr>
<td>VT 53</td>
<td>0.70</td>
</tr>
<tr>
<td>VT 55</td>
<td>0.60</td>
</tr>
<tr>
<td>VT 58</td>
<td>0.50</td>
</tr>
<tr>
<td>VT 60</td>
<td>0.40</td>
</tr>
<tr>
<td>VT 63</td>
<td>0.30</td>
</tr>
<tr>
<td>VT 65</td>
<td>0.20</td>
</tr>
<tr>
<td>VT 68</td>
<td>0.10</td>
</tr>
<tr>
<td>VT 70</td>
<td>0.02</td>
</tr>
</tbody>
</table>

CONCLUSION

From the results of the analysis above, it was found that the capacity of the Darmo road and Pemuda road had an increase in the DS value (degree of saturation) in the post-pandemic period compared to the pandemic conditions during the PSBB period. Ahmad Yani road with a degree of saturation of 1,469 with an average traffic volume of 5,835,
which is far from the threshold. The increase in the value of DS (degree of saturation) can be caused by land use and road functions on Darmo road and the surrounding Pemuda road in the form of city facilities and infrastructures such as bus stops, banks, pharmacies, hospitals, parks, schools, and various shops. The abolition of the WFH (Work From Home) policy made all the above facilities and infrastructure more developed than before due to the increasing population growth resulting in normal community activities returning. This has also resulted in traffic on Darmo road and Pemuda road becoming more congested than during the pandemic.

REFERENCES


