Performance Analysis of Ki Ageng Gribig Road Section due to Malang-Pandaan Toll Gate Development Effect

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Article Info

ABSTRACT

Transportation is one of the driving forces for growing a region. Increase in population and the economic growth of a region resulted in the community needed facilities are increasing. One of the cities that is also experiencing development is Malang City, one of which is Ki Ageng Gribig road which is the access to Malang-Pandaan toll road. This study aims to determine the degree of saturation of Ki Ageng Gribig road section which is around Pandaan-Malang toll gate. This study used a quantitative method and was guided by the 1997 Indonesian Road Capacity Manual. The research was conducted on two sections of the road, before and after entering the toll road. Based on the data obtained from the research survey, the road capacity results were 1473.45 pcu/hour, with a Q value of 2476.1 pcu/hour on road section 1 and a Q of 3230.9 pcu/hour on road section 2. Then, the degree of saturation value obtained at peak hours on the road section 1 is 1.68 and section 2 is 2.19. Both sections of the road have an F value which indicates that this road segment is in a saturated condition. So that attention is needed from the community, especially road users, so that they can pay attention to land use on urban roads so as not to disturb the flow of traffic on Ki Ageng Gribig road.

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1. INTRODUCTION

Transportation is one of the driving forces for growing a region. There are 3 elements of the transportation system such as: network system, activity system and movement system [1]. However, the problem of transportation is a problem that is often faced by both developed and developing countries such as Indonesia. Increasing population growth to high economic growth in an urban area results in the

facilities needed by the community increasing. Transportation problems can also be caused by the relatively high growth of vehicles, inadequate infrastructure, undisciplined drivers, and high development around roads [2]. The lack of control over the number of motorized vehicles has caused harm to many parties. The perceived losses include time, health, and the environment [3].

The general goal of transportation planning is to make mobility easy and efficient. One way is to use the transportation system properly and optimally. If transportation needs are not matched by the development of transportation facilities, it will cause problems such as decreasing the level of service on road sections. The increase in population also makes the need for movement increase [4][5][6]. One of the cities that is also experiencing development is Malang City which has several nicknames, such as Student City, Flower City, Paris East Java and so on. Malang City is also an educational city in East Java [7]. However, Malang City is the third most congested city in Indonesia [8].

Traffic growth need to be balanced by increasing adequate transportation to avoid congestion [9]. The Indonesian government continues to implement national development, one of which is the provision of transportation infrastructure such as toll roads [10]. The city of Malang with an area of 145.28 km2 has a toll road planned for 2017 that will bridge the city of Malang to Surabaya, namely Pandaan-Malang toll road. This toll road is a continuation of Gempol-Pandaan Toll Road and has a planned length of 38.48 km and has 3 areas crossed, namely Pasuruan, Malang City and Malang Regency (East Java Governor Decree dated June 7 2011, number: 188/282/ KPTS/013/2011) [11].

Benefits of Pandaan-Malang Toll Road include improved community connectivity, logistical mobility to boost the economy of the East Java region, and the attractive tourism potential that can be achieved immediately. It not only supports the flow of people mobilization or logistics, but it also facilitates vehicle transportation, so that the travel time between the cities of Malang and Surabaya is only two to three hours. The construction of this toll road started in 2017. The existence of this toll road is considered capable of reducing the number of users of Malang-Pandaan national road, so that congestion can be reduced [12].

Toll roads that stand for tax on location (TOL) are roads that are taxed on the spot when passing through them. Overseas toll roads are called Toll Roads. Toll means fee in English, which means that a fee is charged when passing through the road. Users of this toll road must pay the applicable and appropriate rates to use this facility. Tariff application is based on vehicle class. Toll gate or gate is a building or place where toll facilities are collected. The toll gate located in the Center of Malang City is in Madyopuro Village, Kedungkandang, there is Ki Ageng Gribig road after exiting or before entering the toll road. The existence of toll booths certainly affects the performance of the surrounding traffic flow due to the increased traffic volume to toll road users who will enter or exit via Ki Ageng Gribig road. Therefore it is necessary to solve the traffic performance due to Malang-Pandaan toll exit on Ki Ageng Gribig road. Based on the traffic data from the Department of Transportation for 2017, Ki Ageng Gribig road has a service level of classification D, meaning that this road has indications of heavy traffic and has increased internal barriers, as well as the speed to which vehicles move is regulated by high traffic volume [13]. The intensity of Ki Ageng Gribig road is quite high because this road is one of the main roads [1]. This road is also the main access to Malang-Pandaan toll road. According to the 2010-2030 Malang City Spatial Planning, Ki Ageng Gribig road is part of a strategic area for economic growth in Malang City [14]. Based on this statement, the purpose of this study is to determine the degree of saturation on Ki Ageng Gribig road section which is around Pandaan-Malang toll gate.

2. METHODS

The research design uses quantitative with descriptive research types, as well as for numerical or numerical analysis data collection activities [15], [16]. The data needed for analysis can be obtained directly in the field.

2.1 Research Location

Based on the title taken by the author, the research site is located in 2 parts of Ki Ageng Gribig road, Madyopuro Village, Kedungkandang which has access to Pandaan-Malang Toll Road.
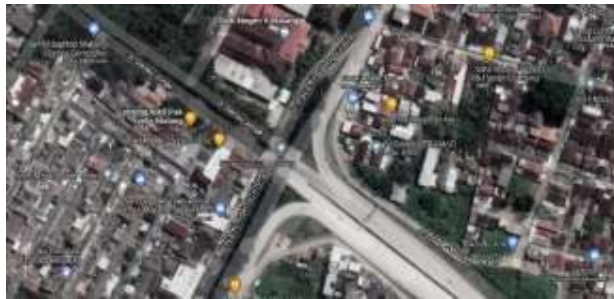

Figure 1. Research Location

2.2 Tools

The equipment used to collect data, namely counters, meters, stationery and mobile phones.

2.3 Data Collection Methods

This study uses primary data and secondary data. Primary data is a field survey that carries out data collection as complete as possible [17]. The primary data needed includes:

a. Geometric Data
    1) The length and width of the road.
    2) Shoulder width.
    3) Median width.
    4) Road type.
b. Traffic Flow Data
    1) Traffic flow.
    2) Vehicle volume.
    3) Travel speed of light vehicles.

Secondary data is a source of information obtained through intermediaries or based on books, existing evidence, notes, or information from related agencies. Secondary data includes:
a. Data on population growth figures for Malang City (taken from the Malang City BPS office)
b. Survey location plan (taken from google maps)

2.4 Conducting Surveys

The survey method is a method that directly conducts research in the field, the purpose of which is to create a systematic, accurate and actual picture of the data that will be collected in the field. The surveys conducted in this data collection are:

a. Geometric Survey

In this method, researchers directly make observations in the field regarding the existing road conditions, especially regarding road geometry.

b. Traffic flow survey

Used to get information about traffic flow, such as traffic volume. The data the required traffic volume from this study was selected from the peak hour conditions [18]. Calculation of traffic flow is done by simply counting the vehicles passing through the observation point.

2.5 Analytical Method

The method used in the analysis of the degree of saturation is:

$$DS = Q/C \tag{1}$$

where the degree of saturation is obtained from the volume of traffic flow divided by the capacity.

a. Traffic Flow Volume

Is the number of vehicles that pass from one point on a certain road section in a certain period of time [19]. Based on vehicle data collected in the field, the number of vehicles per hour will be obtained. Thus, vehicle data at peak hours can be used to analyze the degree of saturation. The value of traffic flow (Q) shows the composition of traffic and expresses traffic flow with junior high schools or passenger car units [20].

b. Capacity

Road capacity has the objective of showing the maximum amount of space available for traffic flow under certain conditions based on road conditions [21]. Determine the capacity value (C) using the equation:

$$C = Co \ x \ FCW \ x \ FCSP \ x \ FCSF \ x \ FCCS \tag{2}$$
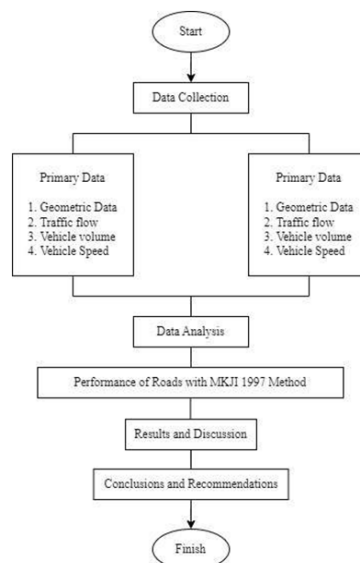
2.6 Planning Flow Chart

Figure 2. Research Flow Chart

3. RESULTS AND DISCUSSION

3.1 Traffic Volume

Traffic data based on the results of field surveys for seven days Monday-Sunday, it is known that the highest road section to Binjai-Semarang on Saturday has a total of 14,123 vehicles/day [21]. Based on LHR calculations, the highest volume occurs on Sunday at 10:00-11:00 WIB with a total of 5568 vehicles on the road section 1 and at 11:00-12:00 WIB with a total of 7123 vehicles on the road section 2.

Table 1. Traffic Volume at Peak Hours Part 1 (Sunday)

Period of Time	CUPS PART 1 (WEEK)				
	MC	LV	HV	Total	
	unit	unit	unit	unit	smp
10:00 - 10:15	837	354	27	1218	556,5
10:15 - 10:30	1004	362	31	1397	603,1
10:30 - 10:45	1053	382	33	1468	635,5
10:45 - 11:00	1017	436	32	1485	681
TOTAL/JAM	3911	1534	123	5568	2476,1

Based on the data captured in Table 1, the peak hours for road section 1 are obtained on Sundays at 10:00-11:00 WIB with a total of 2476.1 pcu/hour.

Table 2. Traffic Volume at Peak Hours Part 2 (Sunday)

Period of Time	CUPS PART 2 (WEEK)				
	MC	LV	HV	Total	
	unit	unit	unit	unit	smp
11:00 - 11:15	1094	514	31	1639	773,1
11:15 - 11:30	1180	493	26	1699	762,8
11:30 - 11:45	1325	496	13	1834	777,9
11:45 - 12:00	1301	627	23	1951	917,1
TOTAL/JAM	4900	2130	93	7123	3230,9

In accordance with Table 2, the peak hours for road section 2 on Sundays are from 11:00 to 12:00 with a total vehicle of 3230.9 pcu/hour.

3.2 Road Capacity

The maximum flow of vehicle traffic that can be maintained in various situations, such as geometric, environmental factors, directional distribution, and traffic composition [22]. Calculation of peak hour capacity, traffic volume in the 2 sections of the road studied, uses the following stages:
a.   Base Capacity
    Based on MKJI for a 4-lane road with a median border or one-way street, the basic capacity value is 1,650 pcu/hour per lane [23].
b.   Capacity Adjustment Factor

Based on existing data on Ki Ageng Gribig road, adjustment factors were obtained by adjusting the guidelines from MKJI [23].
  1) FCW or the correction factor for the influence of traffic lane width on a city road with a 4-lane divided road type with an effective lane width of 3.50 m is 1.00.

2) FCSP. Based on MKJI 1997, divided roads as well as one-way roads, the capacity correction factor as a direction separator cannot be applied, so the FCSP value for Ki Ageng Gribig road is 1.0.
3) FCSF. Based on MKJI, the adjustment factor value in a commercial environment with low side friction is 0.95.
4) FCS or city size adjustment factor based on MKJI 1997 is 0.94, for Malang City with a population of 844,933 people.

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Table 3. Analysis of Road Capacity of Ki Ageng Gribig

No	Adjustment Factor	Mark
1	Basic Capacity (Co)	1650
2	Correction factor on road width (FC_W)	1,0
3	Directional separation cause capacity correction factor(FC_{SP})	1,0
4	Capacity adjustment factor due to side disturbances (FC_{SF})	0,95
5	Capacity adjustment factor due to city/population size (FC_{CS})	0,94
	C = C0 x FCW x FCSP x FCSF x FCCS (smp/jam)	**1473,45**

After obtaining the basic capacity value and the road capacity adjustment factors, the capacity value can be seen in the calculations in Table 3 above. Based on the description in Table 3, the capacity value for Ki Ageng Gribig road is 1473.45.

3.3 Analysis of Degree of Saturation

Is the ratio of flow/current (Q) to capacity (C), which is the main determinant used to determine the performance of intersections and road segments. The value of the degree of saturation explains whether or not there is a capacity problem on the road section [24].

The degree of saturation of road section 1 with a Q value at peak hours (10:00-11:00) is 2476.1 pcu/hour with a value of C = 1473.45 pcu/hour. Then, the value of DS is:

$$DS = \frac{Q}{C}$$

$$DS = \frac{2476,1}{1473,45}$$

$DS = 1,68$

The degree of saturation on the road section 2 with a Q value during peak hours (11:00-12:00) is 3230.9 pcu/hour with a value of C = 1473.45 pcu/hour. Then the DS value is:

$$DS = \frac{Q}{C}$$

$$DS = \frac{3230,9}{1473,45}$$

$DS = 2,19$

Based on the results of the degree of saturation at peak hours, the DS value for road section 1 is 1.68, this value indicates that the road is in saturated condition and the level of service is F. Meanwhile, for road section 2 the value DS = 2.19, then the road is in a saturated condition and the level of service is F. The value of the average degree of saturation for one week for 24 hours on Ki Ageng Gribig Road Part 1 can be seen in Table 4.

Table 4. Degree of Saturation of Ki Ageng Gribig Part 1

| Times | Degree of Saturation of Jalan Ki Ageng Gribig Part 1 | | | |
	Total Vol.	Average Volume	Capacity	DS
06:00-07:00	8432	1204,60	1473,45	0,82
07:00-08:00	10154	1450,54	1473,45	0,98
08:00-09:00	11226	1603,70	1473,45	1,09
09:00-10:00	12213	1744,66	1473,45	1,18
10:00-11:00	14188	2026,80	1473,45	1,38
11:00-12:00	13851	1978,70	1473,45	1,34
12:00-13:00	13278	1896,86	1473,45	1,29
13:00-14:00	13138	1876,91	1473,45	1,27
14:00-15:00	12878	1839,66	1473,45	1,25
15:00-16:00	12644	1806,21	1473,45	1,23
16:00-17:00	13972	1996,04	1473,45	1,35
17:00-18:00	12769	1824,11	1473,45	1,24
18:00-19:00	13455	1922,07	1473,45	1,30
19:00-20:00	11780	182,80	1473,45	1,14
20:00-21:00	9980	1425,71	1473,45	0,97
21:00-22:00	8312	1187,37	1473,45	0,81
22:00-23:00	5881	840,16	1473,45	0,57
23:00-24:00	3034	433,36	1473,45	0,29

The value of the average degree of saturation for one week with a duration of 24 hours on Ki Ageng Gribig road part 2 can be seen in Table 5. The degree of saturation on the Binjai-Semarang arterial road obtained a result of 0.47, so the level of service on this road is C (DS = 0.45 < V/C < 0.74), where the flow is stable, the speed is influenced by traffic, the volume is appropriate for urban roads.

Based on Table 4 and Table 5 it can be seen that Ki Ageng Gribig road has an average DS value at 06:00- 07:00 on section 1 which is 0.82 and section 2 which is 0.78, so that at the current condition is D. Then, at 07:00- 08:00, section 1 has an average DS value of 0.98 and section 2 is 0.95 so that the road section has an E value. At 08:00-20:00 the DS value on this section exceeds one (> 1) then the condition of section is F. At 20:00-21:00 the DS value on section 1 is 0.97 and section 2 is 0.88,

indicating the value of the two sections of the road, namely E. At 21:00-22:00 the road section one has a DS of 0.81 (E) and section 2 of 0.69 (C). At 22:00-23:00 road section 1 has a DS value of 0.57 (C) and road section 2 is worth 0.44 (B). At 23:00-00:00, the DS is 0.29 and 0.25

Table 5. Degree of Saturation of Ki Ageng Gribig Part 2

Times	Degree of Saturation of Jalan Ki Ageng Gribig Part 2			
	Total Vol.	Average Volume	Capacity	DS
06:00-07:00	8041,1	1148,73	1473,45	0,78
07:00-08:00	9847,1	1406,73	1473,45	0,95
08:00-09:00	11040,8	1577,26	1473,45	1,07
09:00-10:00	12056,7	1722,39	1473,45	1,17
10:00-11:00	14059,5	2008,50	1473,45	1,36
11:00-12:00	15552,6	2221,80	1473,45	1,51
12:00-13:00	14602,1	2086,01	1473,45	1,42
13:00-14:00	13415	1916,43	1473,45	1,30
14:00-15:00	12625,7	1803,67	1473,45	1,22
15:00-16:00	12681	1811,57	1473,45	1,23
16:00-17:00	13435,9	1919,41	1473,45	1,30
17:00-18:00	12524	1789,14	1473,45	1,21
18:00-19:00	13472,8	1924,69	1473,45	1,31
19:00-20:00	11385,9	1626,56	1473,45	1,10
20:00-21:00	9085,1	1297,87	1473,45	0,88
21:00-22:00	7102	1014,57	1473,45	0,69
22:00-23:00	4561,6	651,66	1473,45	0,44
23:00-24:00	2595,8	370,83	1473,45	0,25

4. CONCLUSION

Based on the results of a survey at the research location, which was then analyzed by data, the degree of saturation value obtained on Ki Ageng Gribig road section around the Pandaan-Malang toll gate at peak hours was 1.68 and on the section 2 of the road was 2.19. Both road sections have an F value indicating that the road is in saturated condition.

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