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ROAD PERFORMANCE ANALYSIS USING PKJI 2014 METHOD (CASE STUDY : TROSOBO-KLETEK ROAD, SIDOARJO DISTRICT)

by Aulia Dewi Fatikasari

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ROAD PERFORMANCE ANALYSIS USING PKJI 2014 METHOD (CASE STUDY : TROSOBO-KLETEK ROAD, SIDOARJO DISTRICT)

Aulia Dewi Fatikasari^{1*}, Nia Dwi Puspitasari²

^{1,2}Department of Civil Engineering, Engineering Faculty, University of Pembangunan Nasional "Veteran" Jawa Timur, Indonesia

*Corresponding author: aulia.dewi.ts@upnjatim.ac.id

Abstract

The Trosobo-Kletek Highway is one of the roads that has a high level of vehicle density so that it appears that it has experienced traffic jams several times. This is also coupled with the presence of side barriers such as vehicles in and out. So that the Trosobo-Kletek Highway section often experiences traffic jams that occur not only at certain hours, because on this road section there are many factory areas. The important role of this road resulted in a decrease in the level of service. Based on this, it is necessary to monitor the quality of a road segment based on the level of service. In this study, the PKJI 2014 was used to calculate the road performance. As for some of the data needed such as traffic volume, road geometry, and vehicle speed. The analysis carried out is the calculation of Road capacity, peak hour volume, degree saturation, free flow speed, and level of service index. The results of the research conducted during the four days of the survey and the calculations that have been carried out is level of service in the direction of Surabaya-Mojokerto is E and the direction of Mojokerto-Surabaya is F.

Keywords: degree of saturation, highway, level of service, road performance

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INTRODUCTION

Roads have a function as a liaison between an area and other areas to support accessibility and mobility and provide various benefits for life [1]. However, the reality on the ground is that a road that has been built and operated is no longer able to function properly due to problems such as congestion [2].

Congestion is a traffic problem that is very common in urban areas. The causes of congestion problems can come from various factors. In general, there are several causes of congestion, namely the impact of population growth, economic growth, increased number of vehicles, low road capacity, poor urban planning and supervision [3]. The increasing rate of population growth is very high, it will also increase mobility so that this will affect traffic conditions in the transportation sector [4]. Road capacity will form a critical condition that affects the mobility and maneuverability of vehicles in traffic. If the traffic flow is close to capacity, congestion will start to occur. Congestion increases when the current is so great that the vehicles are close to each other. At the time of congestion, the value of the degree of saturation calculated based on the equation $= V/C$ (Volume/Capacity) reached more than 0.75 [5]. In case of total congestion, the vehicle must stop or move slowly [6]. In addition, congestion occurs if the level of service of the road segment is more than 0.7 or includes service level D level [7]. The service level of this class has the characteristics of unstable traffic speed, drivers limiting speed, reduced opportunity to overtake, and traffic volume close to road capacity but still acceptable in the short term.

The greater the value of the ratio of volume and capacity means the more severe the traffic jam on the road. One of the roads that has a high level of traffic volume is the Trosobo-Kletek Highway.

The Trosobo-Kletek Highway is one of the roads that is prone to congestion [8]. The Trosobo-Kletek Highway has a 4/2 D type with a road length of ±8 km. Based on government administration and load, Jalan Raya Kletek is categorized as a National Road. According to Law no. 22 of 2009 concerning road traffic and transportation, national roads are included in the class I road category, namely arterial and collector roads that can be passed by vehicles with a maximum axle load of 10 tons of heaviest axle. The Trosobo-Kletek Highway is a provincial road that connects the city of Surabaya with various regencies and cities that do not use toll roads. Thus this road plays an important role in serving a fairly large traffic flow. The Trosobo-Kletek Highway is often seen passing through various types of small vehicles and large vehicles such as multi-axle trucks, trailer trucks, tanker trucks, dump trucks, flat deck trucks, and others [9]. However, many of these trucks exceed the standard capacity that has been determined, one of which is a truck that transports construction materials which can be said to exceed the standard capacity [10]. In this case, the most dominant and the most influential in congestion are trucks that have overloads. This condition significantly increases the potential for serious problems with vehicles and causes road congestion.

The Trosobo-Kletek Highway is one of the roads that has a high level of vehicle density so that it appears that

it has experienced traffic jams several times. This is also coupled with the presence of side barriers such as vehicles in and out. So that the Trosobo-Kletek Highway section often experiences traffic jams that occur not only at certain hours, because on this road section there are many factory are. The important role of this road resulted in a decrease in the level of service. The performance of a road segment can be seen from the Level of Service (LOS) index of road traffic which can be assumed as the quality that road users will feel from road conditions and traffic conditions, and can be described as one of the perceptions of road users and traffic managers on traffic [11].

Based on this, it is necessary to monitor the quality a road segment based on the level of service. The performance indicators are traffic flow (Q), capacity (C), degree of saturation (DS), free flow speed carried out with various performance indicators, name free flow speed (FV), as well as analyzing the level of service level (Level of Service/LOS) on the road segment. In this study, the PKJI 2014 was used to calculate the road performance. As for some of the data needed such as traffic volume, road geometry, and vehicle speed. The analysis carried out is the calculation of Road capacity, peak hour volume, degree saturation, free flow speed, and level of service index.

RESEARCH METHODS

The preparation of the research required a flow of thought and implementation from the beginning to the end of writing. The flow chart in the preparation of this research can be seen in Figure 1.

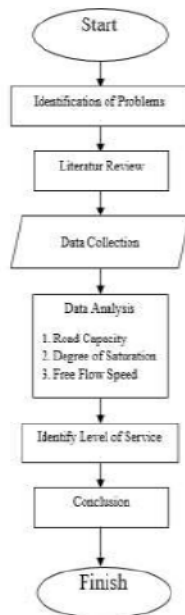


Figure 1 Flowchart
(Source: Result of the Research)

The method used to analyze the performance of the Kletek Highway segment, Sidoarjo District is the PKJI 2014 method

Data Collection

The first stage of this research is the collection of the required data. The data used in this study is primary data consisting of side barriers, traffic volume, vehicle speed, and road geometry. Traffic volume data collection is by using CCTV installed around roads for 4 x 24 hours, namely on weekends (Saturdays and Sundays and on weekdays (Mondays and Tuesdays).

Data Analysis

The analytic phase consists of calculating the traffic volume during peak hour in the form of light vehicle units (cur), road segment capacity, degree of saturation, free flow speed, and vehicle travel speed.

Analysis of traffic volume during peak hour is the highest total number of vehicles for 1 hour. The first step is to multiply each number of vehicles by the equivalent value of the light vehicle. Furthermore, the number of vehicles with light vehicle units (cur) every 15 minutes is added up to become an hourly accumulation. At certain hours, the one with the highest number of vehicles will be selected as peak hour.

The calculation of road capacity, degree of saturation, and free flow speed is based on the PKJI 2014 method. The calculation of the value of vehicle travel speed is by dividing the length of the specified road segment by the average travel time along the calculated road segment

Conclusion

The conclusions drawn are based on the results of the analysis phase. The results of this study are expected to describe the level of service segment, so that if the value of the degree of saturation studied has a very high value, the condition of the road needs to be evaluated.

RESULTS AND DISCUSSIONS

Location and Road Geometry

The location of the road to be researched is the Trosobo-Kletek road section, Sidoarjo District. This road section becomes access to various types and sizes of vehicles, including heavy vehicles. This road has a high level of vehicle density so that it appears that it has experienced traffic jams several times. Research site map which will be reviewed is shown in Figure 2.



Figure 2 Research Site Map
(Source: <https://www.google.com/maps>)

Kletek Highway is primary arterial road that connects Surabaya with several regencies and cities that do not pass through the toll road, one of which is the City of Mojokerto. The following is the geometry of the Kletek Highway segment.

- a. Number of lanes = 4/2 D
- b. Pavement width = 13.2 meters
- c. Effective width = Left (M-S) = 6,6 meters
Right (S-M) = 6,6 meters
- d. Road shoulder width = 4,5 meters for right/left
- e. Effective shoulder = Left (M-S) = 2 meters
Right (S-M) = 2,5 meters
- f. Direction separator = 50-50
- g. Side resistance = Very high

The geometry of the Kletek Highway can be seen in Figure 3.

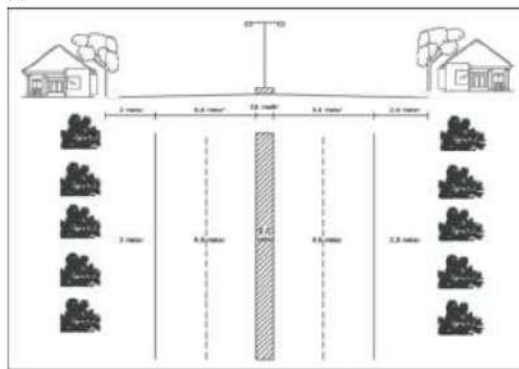


Figure 3 Road Geometry
(Source: Result of the Research)

Traffic Volume

The volume is then calculated based on the number of vehicles crossing a certain point on the road every 15 minutes. All traffic flow values are converted into light vehicle units (cur) using the light vehicle equivalent value for the following types of vehicles [5]:

1. Light vehicles (LV), including passenger cars, minibuses, pickup trucks and jeeps;
2. Medium heavy vehicles (MHV), including two-axle trucks and small buses;
3. Big Bus (BB)
4. Large trucks (LT), including three or more axle trucks, outboard trucks, and trailer trucks; and
5. Motorcycle (MC)

Traffic volume during peak hour is the amount of traffic flow with the largest light vehicle unit (cur) at a certain hour. Calculation of traffic volume to be converted into light vehicle units using the following formula.

$$Q = [(ekrLV \times qLV) + (ekrBB \times qBB) + (ekrMV \times qMV) + (ekrLV \times qLV) + (ekrMV \times qMC)] \quad (1)$$

Description

- Q : number of vehicle flows (current)
- ekrLV : equivalence value of light vehicle type light vehicle
- qLV : number of light vehicles (vehicles)
- ekrBB : equivalence value of light vehicle type large bus
- qBB : number of big buses (kend)
- ekrMV : equivalence value of light vehicle types of medium heavy vehicles
- qMV : number of medium heavy vehicles (KBM)
- ekrLV : equivalence value of light vehicle types of large trucks
- qLV : number of large trucks (TB)
- ekrMC : equivalence value of light vehicle type motorcycle
- qMC : number of motorcycles

The graph of vehicle flow in light vehicle units (cur) every hour can be seen in Figure 3 until Figure 6.

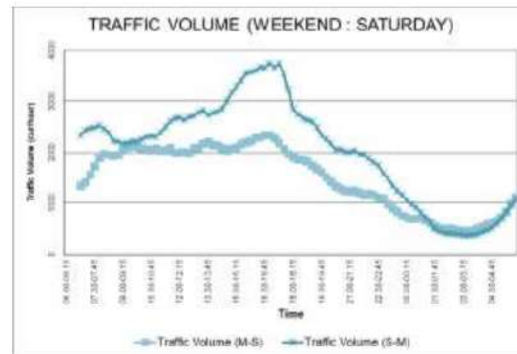


Figure 3 Traffic Volume (Weekend : Saturday)
(Source: Result of the Research)

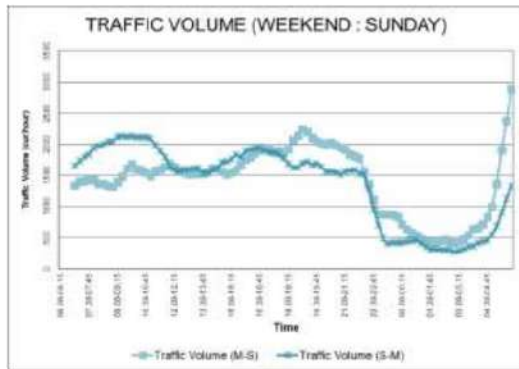


Figure 4 Traffic Volume (Weekend : Sunday)
(Source: Result of the Research)

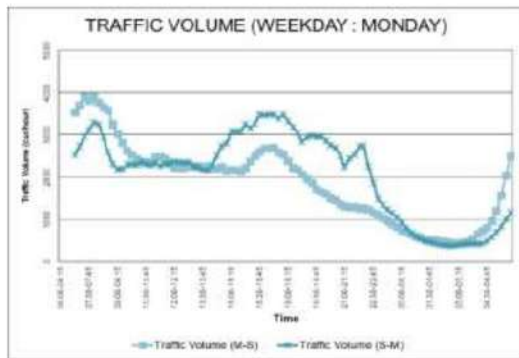


Figure 5 Traffic Volume (Weekday : Monday)
(Source: Result of the Research)

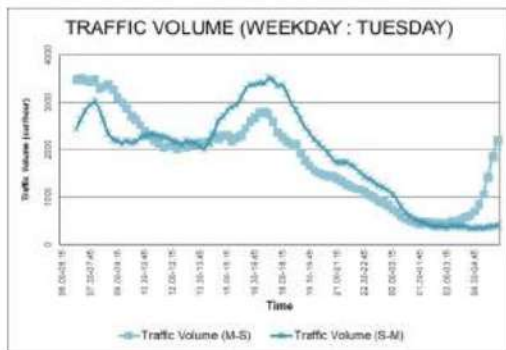


Figure 6 Traffic Volume (Weekday : Tuesday)
(Source: Result of the Research)

From the results of the calculations shown in the graph, it is found that peak hours on Trosobo-Kletek Highway in the direction of Surabaya-Mojokerto during weekends on

on Sundays at 08.30 a.m until 09.30 a.m and Saturdays at 04.00 p.m until 05.00 p.m. On weekdays, Mondays are at 04.15 p.m until 05.15 p.m. and on Tuesdays at 04.30 p.m until 05.30 p.m. Meanwhile, the peak hour for the direction of Mojokerto-Surabaya is on the weekend on Sunday at 05.00 a.m until 06.00 a.m and on Saturday at 04.00 p.m until 05.00 p.m. On weekdays, on Mondays at 06.30 a.m until 07.30 a.m and on Tuesdays at 06.15 a.m until 07.15 a.m. The results of the vehicle volume recap during peak hours can be seen in the Table 1.

Table 1 Peak Hour Volume

Direction	Peak Hour Volume (cur/hour)			
	Weekend		Weekday	
	Saturday	Sunday	Monday	Tuesday
M-S	2.340	2.879	3.911	3.514
S-M	3.517	2.129	3.483	3.521

(Source: Result of the Research)

From the results of the calculations shown in the table, it is found that peak hours volume on Jalan Raya Trosobo-Kletek in the direction of Surabaya-Mojokerto during weekends on Saturday is 3.147 cur/hour and on Sunday is 2.129 cur/hour. On weekdays, Monday is 3.483 cur/hour and on Tuesday is 3.521 cur/hour. Meanwhile, the peak hour for the direction of Mojokerto-Surabaya is on the weekend on Saturday is 2.340 cur/hour and on Sunday is 2.879 cur/hour. On weekdays on Monday is 5.711 cur/hour. and on Tuesdays is 3.514. During the four-day survey, the highest traffic volume value was obtained, namely the direction of Mojokerto-Surabaya with a volume of 3.911 cur/hour.

Road Capacity

The calculation of the road segment capacity based on the PKJI 2014 uses the following formula.

$$C = Co \times FClj \times FCpa \times FChs \quad (2)$$

Description :

C : road capacity, cur/hour

Co : base capacity, cur/hour

FClj : adjustment factor related to lane width

FCpa : adjustment factor related to direction separation

FChs : adjustment factor related to side resistance

From the calculation results, it is found that the capacity of the road for the direction of Surabaya-Mojokerto and the direction of Mojokerto-Surabaya is 3.531 cur/hour.

Degree of Saturation

The degree of saturation is the ratio between traffic flow to capacity [5]. The value of the degree of saturation is used to determine traffic performance on the road segment. Calculation of the degree of saturation using the following formula [5].

$$DS = \frac{Q}{C} \quad (2)$$

Description :

- DS : degree of saturation
- Q : traffic flow (cur/hour)
- C : road segment capacity (cur/hour)

The value of the degree of saturation on weekends and weekdays is shown in Table 2 .

Table 2 Degree of Saturation

Direction	Degree of Saturation			
	Weekend		Weekday	
	Saturday	Sunday	Monday	Tuesday
M-S	0.663	0.815	1.108	0.995
S-M	0.996	0.603	0.986	0.997

(Source: Result of the Research)

From the calculation results, it is found that the value of the degree of saturation in the direction of Surabaya-Mojokerto during the weekend on Saturday is 0,996 and on Sunday is 0,603. On weekdays, Monday is 0,986 and on Tuesday is 0,997. Meanwhile, the peak hour for the direction of Mojokerto-Surabaya is on the weekend on Saturday is 0,663 and on Sunday is 0,815. On weekdays on Monday is 1,108 and on Tuesday is 0,995. During the four-day survey, the highest degree of saturation was obtained, namely the direction of Mojokerto-Surabaya with a value of 1.108.

Free Flow Speed

Free flow speed (FV) is defined as the speed at zero current level, i.e. the speed the driver would choose when driving a motor vehicle without being affected by other motorized vehicles on the road. The calculation of the free flow velocity uses the following formula [5].

$$FV = (FV_o + FV_w) \times FFV_{SF} \times FFV_{CS} \quad (3)$$

Description :

- FV_o : Free flow speed (km/h)
- FV_w : Basic free flow speed (km/h)
- FFV_{SF} : Adjustment factor due to traffic lane width
- FFV_{CS} : Adjustment factor due to side resistance
- FFV_{CS} : Adjustment factor due to land use

The results of the calculation of the free flow speed can be seen in Table 3. From the results of the calculation of the free flow speed and the value of the degree of saturation, the vehicle travel speed can be seen in Table 4 and Table 5.

Table 3 Free Flow Speed

No.	Type of vehicle	Free Flow Speed (FV)

1	Light Vehicle (LV)	69,82 km/jam
2	Medium Heavy Vehicles (MHV)	58,18 km/jam
3	Big Bus (BB)	72,51 km/jam
4	Large trucks (LT)	55,50 km/jam
5	Motorcycle (MC)	57,29 km/jam
Average		62,66 km/jam

(Source: Result of the Research)

Tabel 4 Travel Speed (Mojokerto-Surabaya)

Day	DS	Travel Speed (km/jam)					AVERAGE	
		LV	MHV	BB	LT	MC		
Week end	Saturday	0.66	40.47	36.16	42.61	34.06	35.46	37.75
	Sunday	0.82	39.98	31.62	36.92	29.60	39.94	35.61
Week day	Monday	1.11	23.91	18.09	20.51	16.75	17.65	19.38
	Tuesday	1.00	24.71	18.78	21.31	17.41	18.32	20.10

(Source: Result of the Research)

Tabel 5 Travel Speed (Surabaya-Mojokerto)

Day	DS	Travel Speed (km/jam)					AVERAGE	
		LV	MHV	BB	LT	MC		
Week end	Saturday	0.996	19.55	18.64	23.15	17.27	23.18	20.36
	Sunday	0.603	42.74	38.19	44.89	30.97	37.45	38.85
Week day	Monday	0.986	21.15	20.00	22.75	18.59	19.53	20.40
	Tuesday	0.997	19.39	18.50	22.99	17.14	23.05	20.21

(Source: Result of the Research)

From the results of the calculations in Table 4 and Table 5, it is found that the lowest average travel speed for the direction of Mojokerto-Surabaya is 19,38 km/hour during Weekday (Monday) and for the direction of Surabaya-Mojokerto which is 20,21 km/hour during Weekday (Tuesday).

Level of Service

The level of service is used to determine the quality of roads that serve traffic flow. [12]. The level of service describes the operational conditions of traffic flow and the perception of drivers in terms of speed, travel time, comfort, freedom of movement, security and safety [23].

The road service level is divided into six classes from A to F which state the best to the worst service level. The level of service can be seen in the Table 6 [14]. The results of the calculation of the level of service on weekends and weekdays can be seen in the Table 7.

Tabel 6 Level of Service Index

Level of Service Index	Traffic Flow Condition	Ratio V/C
A	Free traffic flow conditions with high speed and low traffic volume.	0,00-0,20
B	The flow is steady, but the operating speed starts to be limited by traffic conditions	0,20-0,44
C	Steady flow, but controlled vehicle speed and motion	0,45-0,74
D	The current is almost unstable, the speed can still be controlled, the V/C can still be tolerated.	0,75-0,84
E	Unstable flow speed with frequent stops; demand is approaching capacity.	0,85-1,00
F	Forced flow, low speed, volume above capacity, long queues (congested)	≥1

(Source:MKJI (1997))

Tabel 7 Results of Calculation Level of Service on the Trosobo-Kletek Highway

Direction	Level of Service			
	Weekend		Weekday	
	Saturday	Sunday	Monday	Tuesday
M-S	C	D	F	E
S-M	E	C	E	E

(Source: Result of the Research)

From the results of the table calculations, it is found that the level of service on Jalan Raya Trosobo-Kletek in the direction of Surabaya-Mojokerto on weekends on Saturday is "E" and on Sunday is "C". On weekdays, Monday and Tuesday is "E". Meanwhile, the level of service for the direction of Mojokerto-Surabaya is on the weekend on Saturday is "C" and on Sunday is "D". On weekdays on Monday is "F" and on Tuesday is "E". During the four-day survey, the lowest level of service was found in the Mojokerto-Surabaya direction with a level of service index of F then the traffic flow condition is "Forced flow, low speed, volume above capacity, long queues (congested).

CONCLUSION

The results of research conducted for four days of surveys and calculations that have been carried out, the following conclusions are obtained:

1. The peak hour volume on the Kletek highway in the direction of Surabaya-Mojokerto is 3.521 cur/hour with

an average travel speed of 20.21 km/hour and the direction of Mojokerto-Surabaya is 3,911 cur/hour with an average travel speed of 19.38 km/hour.

2. The degree of saturation on the Kletek highway in the direction of Surabaya-Mojokerto is 0,997 and the direction of Mojokerto-Surabaya is 1,108.
3. The level of service on the Kletek highway in the direction of Surabaya-Mojokerto is E then the traffic flow condition is "Unstable flow speed with frequent stops; demand is approaching capacity" and the direction of Mojokerto-Surabaya is F then the traffic flow condition is "Forced flow, low speed, volume above capacity, long queues (congested).

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