TEKNIKA: JURNAL SAINS DAN TEKNOLOGI

Homepage jurnal: http://jurnal.untirta.ac.id/index.php/ju-tek/

Determine peak hour factor (PHF) based on road type and peak hour time on arterial roads for capacity analysis in East Surabaya

***Aulia Dewi Fatikasari*[a,1], *Achmad Dzulfiqar Alfiansyah*[a], *Rikky Sofyan Rizal*[b], *Primasari Cahya Wardhani*[c]**

[a]*Department of Civil Engineering, Universitas Pembangunan Nasional Veteran East Java, Jl. Rungkut Madya No.1, Gn. Anyar, Kec. Gn. Anyar, Surabaya, East Java 60294, Indonesia*

[b]*Department of Road and Bridge Design Engineering, Politeknik Negeri Jakarta, Jl. Prof. DR. G.A. Siwabessy, Kukusan, Beji, Depok City, West Java 16425, Indonesia*

[c]*Department of Physics, Universitas Pembangunan Nasional Veteran East Java, Jl. Rungkut Madya No.1, Gn. Anyar, Kec. Gn. Anyar, Surabaya, East Java 60294, Indonesia*

[1]Corresponding author: aulia.dewi.ts@upnjatim.ac.id

ARTICLE INFO

Article history:
Submitted 28 June 2023
Received 29 June 2023
Received in revised form 20 July 2023
Accepted 5 August 2023
Available online on 30 November 2023

Keywords:
Peak hour volume (PHV), peak hour factor (PHF), East Suarabaya, residual capacity.

Kata kunci:
Volume jam puncak (VJP), faktor jam puncak (FJP), Surabaya Timur, kapasitas sisa.

ABSTRACT

The peak hour factor (PHF) is one of the important factors in planning a road. This factor is used to predict the traffic volume in the planned year of a road. So calculating this factor is very important in planning road capacity so that a road can serve traffic flows well during its design life. The Peak hour factor (PHF) value will vary for each region, each type of road, and each peak hour depending on the traffic flow on that road section. East Surabaya is an industrial and office center area so there are frequent fluctuations in traffic flow at certain hours. This research aims to analyze the Peak hour factor (PHF) value on the arterial road network system in East Surabaya based on road type and peak hour time. The methods used are traffic volume surveys, peak hour volume (PHV) calculations, peak hour factor (PHF) analysis, and residual capacity analysis. The results obtained from this research are that each road section has a different peak hour volume (PHV) time depending on the volume of traffic passing through that road. Apart from that, the type of road and the time peak volume occurs will differentiate the peak hour factor (PHF) value on a road section. Overall, the peak hour factor (PHF) value for arterial roads in East Surabaya with road type 6/2 D is in the range of 0.76-0.97 with an average of 0.91 and road type 4/2 in the range of 0.89 – 0.95 with an average of 0.93.

ABSTRAK

Peak hour factor (PHF) merupakah salah satu faktor penting dalam merencakan suatu jalan. Faktor ini digunakan untuk memprediksikan jumlah volume lalu lintas di tahun rencana suatu jalan. Sehingga perhitungan faktor ini sangat penting dalam merencanakan kapasitas jalan agar suatu jalan dapat melayani arus lalu lintas selama umur rencana dengan baik. Nilai peak hour factor (PHF) akan berbeda-beda setiap daerah, setiap tipe jalan, dan setiap jam Puncak tergantung dari arus lalu lintas pada ruas jalan tersebut. Surabaya Timur merupakan daerah pusat industri dan perkantoran sehingga sering terjadi fluktuasi arus lalu lintas pada jam-jam tertentu. Penelitian ini bertujuan untuk menganalisis nilai peak hour factor (PHF) pada sistem jariangan jalan arteri di Surabaya Timur berdasarkan tipe jalan dan waktu jam Puncak. Metode yang digunakan yaitu survei volume lalu lintas, perhitungan peak hour volume (PHV), analisis peak hour factor (PHF), dan analisis kapasitas sisa. Hasil yang didapatkan dari penelitian ini yaitu setiap ruas jalan memiliki waktu terjadi peak hour volume (PHV) yang berbeda-beda tergantung dari jumlah volume lalu lintas yang melewati jalan tersebut. Selain itu, tipe jalan dan waktu penentuan terjadinya volume puncak akan membedakan nilai peak hour factor (PHF) pada suatu ruas jalan. Secara keseluruhan, nilai peak hour factor (PHF) ruas jalan arteri di Surabaya Timur dengan tipe jalan 6/2 D berada pada rentang 0,76-0,97 dengan rata rata 0,91 dan tipe jalan 4/2 pada rentang 0,89 – 0,95 dengan rata-rata 0,93.

Available online at http://dx.doi.org/10.36055/tjst.v19i2.21918

1. Introduction

Roads are a means of land transportation that play an important role in the development of a region [1]. The main function of roads is as a means of connecting one area to another, which plays a role in increasing accessibility and mobility and providing some significant benefits in life [2]. In planning a road section, traffic volume data is needed. Traffic volume data is an important variable in building a road and evaluating traffic performance to measure the road's ability to provide services to road users [3]. Traffic volume calculations have a huge impact on road performance. If there is an error in calculating the traffic volume, it will cause faster road damage, namely a decrease in road quality which is calculated based on road performance where the traffic volume approaches the road capacity value faster than the capacity's planned life. Errors in calculating traffic volumes will potentially result in inefficiencies because they result in the expenditure of greater funds for road maintenance or increasing road capacity before reaching the planned benefit value. Roads should be prepared for a planned service life, based on careful economic, financial and environmental feasibility analysis. In addition, traffic volume will determine future land requirements to support movement by the spatial plan. Road planning is based on assessing the traffic performance on the road, whether it can still accommodate traffic flow or whether existing roads need to increase capacity. The planning process is based on an analysis of the amount of traffic flow during the planning hours which can illustrate the prediction of the amount of traffic volume that will use the road section during the life of the plan. In planning to calculate the planned hourly traffic flow, there are three parameters needed, namely the average daily traffic volume, k factor, and peak hour factor (PHF) [4], [5].

Peak hour factor (PHF) describes variations in traffic flow every 15 minute interval within one hour of busy traffic volume. Peak Hour Factor (PHF) is important in planning analysis because it describes situations with critical traffic volumes and is the basis for designing a road. Currently, no one uses the peak hour factor value to evaluate performance or analysis planning in Indonesia [6] , [3]. A high level of traffic flow variation (in the range of 0.7-0.9) can cause a significant increase in traffic volume in the range of 11%-33% [6]. This increase in traffic can impact vehicle queues, especially during rush hours, resulting in long periods at low speeds [7]. Apart from being used to determine the planned hourly volume, the peak hour factor (PHF) can also be used to quantify the effects of traffic in the short term, especially related to congestion and road safety [8].

Peak hour factor (PHF) values can vary based on time, road type, location, direction of movement, network system classification, population and other variables [7] , [9] . Each road section has a different Peak hour factor value depending on the increase in volume. On urban roads with high traffic fluctuations, the peak hour factor (PHF) value will vary greatly from day to day or location to location, both at road segments and intersections. Each big city in Indonesia has different roads according to the city's traffic needs. Surabaya is one of the largest metropolitan cities in Indonesia which consistently experiences population growth. Surabaya is ranked second as a metropolitan city after Jakarta, and acts as the capital of East Java Province [10]. The population of Surabaya in 2022 will reach 2,972,801 people [11]. The greater the city's population, the more development projects will be supported in big towns, encouraging significant economic growth. Economic growth will encourage increasingly rapid population mobility from year to year, which indicates the process of change in a region [12]. East Surabaya is an area with a high level of community activity. This is because the area is an industrial and office center. The increasing number of community activities in the social, economic and social sectors in the City Center area has resulted in high mobility occurring[13] [14]. This mobility takes the form of the movement of people and goods. The higher mobility is indicated by the greater movement of people and goods from one place to another, one of which is the large volume of traffic passing through road facilities at certain hours. The rush hour often occurs in Surabaya at 07.00 and 16.00 [15]. A road section is planned based on the traffic volume that will pass through that road section. Road construction must be adjusted to demand to produce efficient, safe, economical and comfortable vehicle travel [6]. The large number of community activities in the East Surabaya area will cause high vehicle mobility, resulting in traffic flow variations. Variations in traffic flow for each road section in the East Surabaya area will provide different peak hour factor (PHF) values. Peak hour factor (PHF) is used in road capacity analysis in road planning because at certain times of the day there is an increase in traffic volume, a road section is planned to be able to serve traffic flow with good quality.

Research related to peak hour factor (PHF) on the road network in the East Surabaya area has never been carried out with variations in road types and peak hours. For this reason, this study aims to estimate the value of the peak hour factor on the arterial road network in the East Surabaya area with variations in road types and peak hour approaches. This research shows that the peak hour factor (PHF) value in East Surabaya can be used to predict the volume of planned hours in the urban road network system in East Surabaya.

2. Method

2.1. Data Collection

The data used in this research are Primary Data and Secondary Data. Secondary data is data obtained from existing sources, namely in the form of data on the population of Surabaya obtained from the Central Statistics Agency (BPS). Primary data from direct surveys in the field includes traffic volume data and road section geometry data. Traffic volume surveys were carried out on each road section and in each direction. Traffic volume is recorded every 5 minutes in the morning on Monday from 06.00 to 10.00 and in the afternoon on Friday from 15.00 to 19.00. Geometry data of the road sections were obtained by making direct measurements in the field using a meter in the form of the type of road segment, road width, road shoulder width, curb width, and side obstacle conditions.

2.2. Traffic Volume Analysis

The results of the traffic volume survey were analyzed by categorizing the volume into three types of vehicles: light vehicles, heavy vehicles and motorcycles. Furthermore, traffic volume data that has been categorized into three types of vehicles are equated to light vehicle units by multiplying the vehicle volume by the light vehicle equivalent value (cur) according to each vehicle type. Traffic volume data with units of light vehicles (cur) with records every 5 minutes are cumulative every one hour and then analyzed to find the highest traffic volume.

2.3. Peak Hour factor Analysis

The Peak Hour Factor analysis is defined as the hourly volume divided by the peak flow rate of 15 minutes during peak hours. The traffic volume analyzed down to light vehicle units per hour (pcu/hour) in each direction is added up for each road section. Next, look for the time when the highest volume occurred

on that road section and then re-describe every 5 minutes the number of each light vehicle, heavy vehicle and motorbike in each direction. The results of the description of the traffic volume every 5 minutes are summed up to every 15 minutes and the highest volume every 15 minutes is sought. The Peak hour factor value is calculated based on the total volume during peak hours (cur/hour) divided by the total volume of 15 minutes during peak hours.

2.4. Residual Capacity

Residual capacity remains when traffic volume reaches its peak and is measured in percentage terms. Residual capacity analysis is obtained by subtracting the peak hour factor percentage value. Maximum capacity is calculated as 1 or 100%. Remaining capacity is the capacity that is still available when traffic volume reaches its peak. When the peak hour factor is higher, the remaining capacity will decrease. Conversely, the peak hour factor needs to be reduced to achieve greater remaining capacity.

3. Result and Discussion

3.1. Research Location

This research was carried out on six road sections in the East Surabaya Region with ideal geometric conditions, as seen in Table 1. A map of the research location can be seen in Figure 1. The road sections consist of 3 types of 6/2 D roads and 3 with type 4/2 D. On 6/2 D or 4/2 D road type, observations are made per direction so that the Peak Hour Factor (PHF) obtained is PHF per direction.

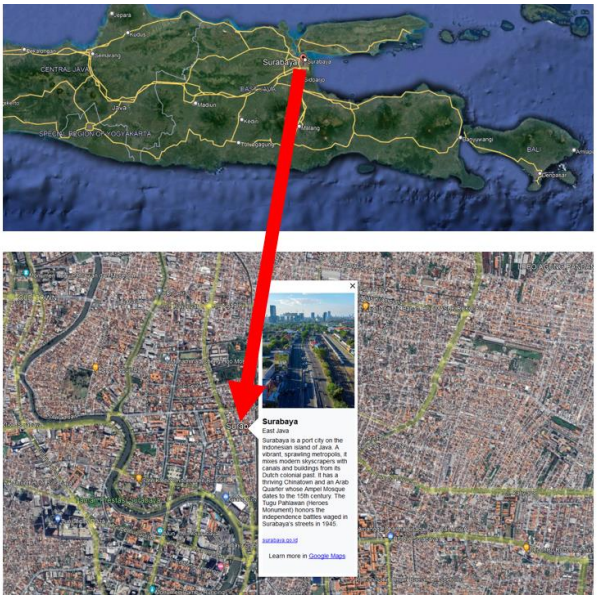

Figure 1. Research Location Map

Table 1. Research Location

No.	Road Name	Road Type	Road Width	
			Direction 1 (m)	Direction 2 (m)
1	Prapen St.	6/2 D	10	9,9
2	Jemursari St.	6/2 D	10	9,9
3	Panjang Jiwo St.	6/2 D	9,9	9,3
4	Jemur andayani St.	4/2 D	7	7
5	Kali Rungkut St.	4/2 D	6,8	6,8
6	Rungkut Industri Raya St.	4/2 D	7,4	7,4

3.2. Traffic Volume

The traffic volume used in this study is the number of vehicles that pass a certain point recorded at 5-minute intervals through field surveys. Data was collected on type 4/2 T and 6/2 T city roads with ideal geometric conditions. After that, the number is converted into units of light vehicles (cur) by applying a conversion factor, namely the equivalent value of light vehicles (pce) according to the type of each vehicle. Calculation of traffic volume in units of light vehicles (cur) is carried out using the equation (1):

$$Q = [(pceLV\ x\ qLV) + (pceHV\ x\ qHV) + (pceMC\ x\ qMC), \quad (1)$$

where:

pce LV = PCE value for light vehicle,
qLV = number of light vehicle,
pce HV = PCE value for heavy vehicle,
qHV = number of heavy vehicle,

pce MC = PCE value for motorcycle, and
qMC = number of motorcycle.

The results of the peak traffic volume analysis for roads in East Surabaya in the morning can be seen in Table 2 and the traffic volume graph in Figure 2. The results of the analysis of peak traffic volumes for roads in East Surabaya in the afternoon can be seen in Table 3 and the traffic volume graph in Figure 3.

Table 2. Analysis of Highest Volume at Morning Peak Hours

No.	Road Name	Dircetion 1		Dircetion 2	
		Time	Volume (cur/hour)	Time	Volume (cur/hour)
1	Prapen St.	07.35-08.35	3138	07.20-08.20	2256
2	Jemursari St.	07.20-08.20	2048	07.05-08.05	1945
3	Panjang Jiwo St.	07.25-08.25	2724	07.00-08.00	1568
4	Jemur andayani St.	07.15-08.15	1805	07.15-08.15	1769
5	Kali Rungkut St.	07.20-08.20	930	07.05-08.05	2004
6	Rungkut Industri Raya St.	07.25-08.25	858	07.05-08.05	1761

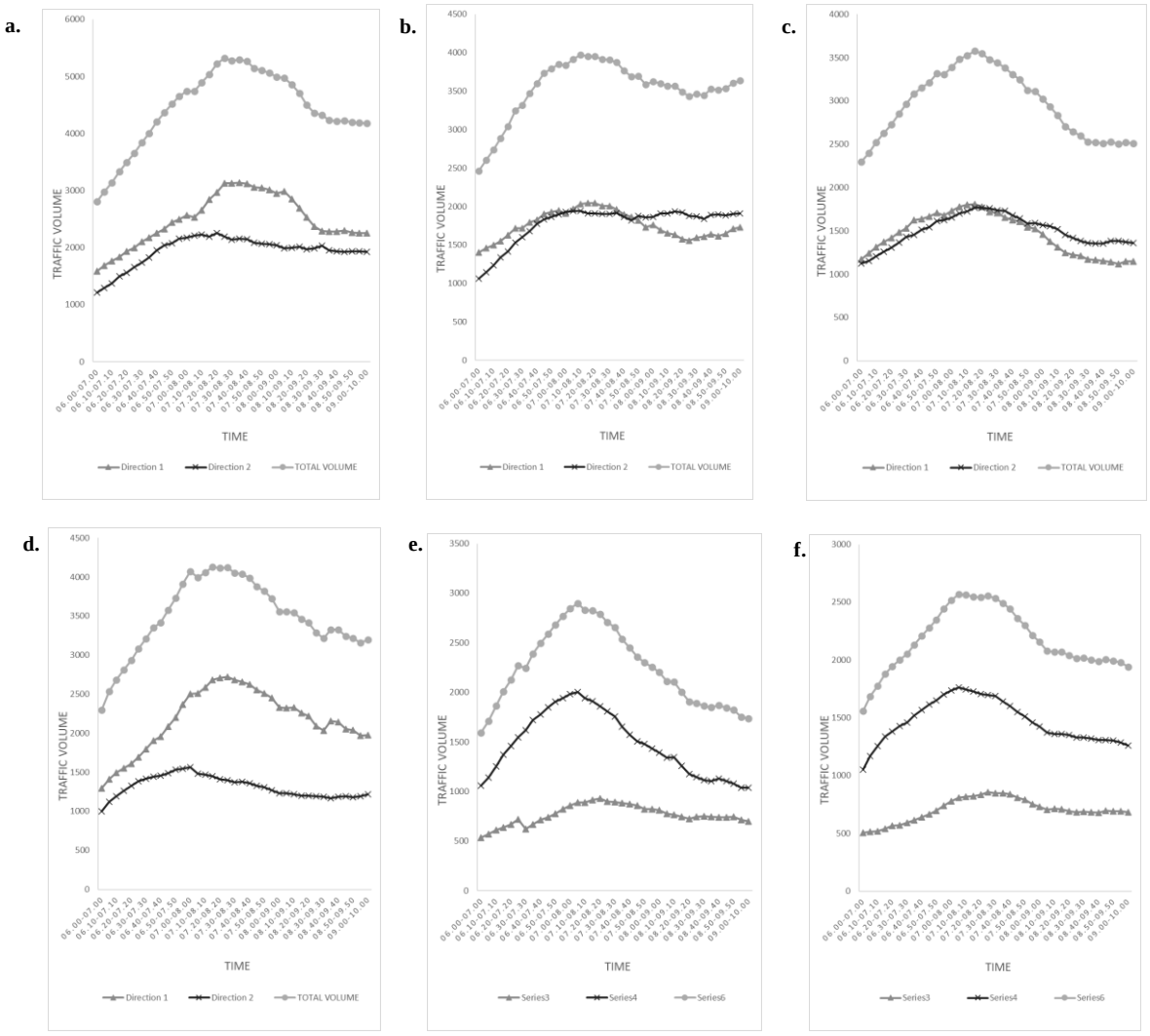

Figure 2. Traffic Volume at Morning Peak Hours (a) on Prapen St. ; (b) on Jemursari St. ; (c) on Jemur Andayani St. ; (d) on Panjang Jiwo St. ; (e) on Kali Rungkut St. ; (f) on Rungkut Industri Raya St.

Based on the results of the analysis of the highest traffic volume in the morning on roads in the East Surabaya Area direction 1, On Prapen St. has a Traffic Volume of 3138 cur/hour at 07.35-08.35 a.m, on Jemursari St. has Traffic Volume 2048 cur/hour at 07.20-08.20 a.m, on Jemur Andayani St. has Traffic Volume 1805 cur/hour at 07.15-08.15 a.m, on Panjang Jiwo St. has Traffic Volume 2724 cur/hour at 07.25-08.25 a.m, on Kali Rungkut St. has Traffic Volume 930 cur/hour at 07.20-08.20 a.m, and on Rungkut Industri Raya St.has Traffic Volume 858 cur/hour at 07.25-08.25 a.m. Based on the results of an analysis of the highest traffic volume in the morning on roads in the East Surabaya Area direction 2, On Prapen St. has Traffic Volume 2256 cur/hour at 07.20-08.20 a.m, on Jemursari St. has Traffic Volume 1945 cur/hour at 07.05-08.05 a.m, on Jemur Andayani St. has Traffic Volume 1769 cur/hour at 07.15-08.15 a.m, on Panjang Jiwo St. has Traffic Volume 1568 cur/hour at 07.00-08.00 a.m, on Kali Rungkut St. has Traffic Volume 2004 cur/hour at 07.05-08.05 a.m, and on Rungkut Industri Raya St.has Traffic Volume 1761 cur/hour at 07.05-08.05 a.m.

Table 3. Analysis of Highest Volume in the Afternoon Peak Hours

No.	Road Name	Dircetion 1		Dircetion 2	
		Time	Volume (cur/hour)	Time	Volume (cur/hour)
1	Prapen St.	16.15-17.15	2311	16.05-17.05	2778
2	Jemursari St.	16.15-17.15	1721	15.40-16.40	3025
3	Jemur andayani St.	15.35-16.35	1434	17.00-18.00	1638
4	Panjang Jiwo St.	16.20-17.20	5947	15.40-16.40	2012
5	Kali Rungkut St.	16.35-17.35	1513	16.00-17.00	1554
6	Rungkut Industri Raya St.	16.35-17.35	1001	16.30-17.30	1581

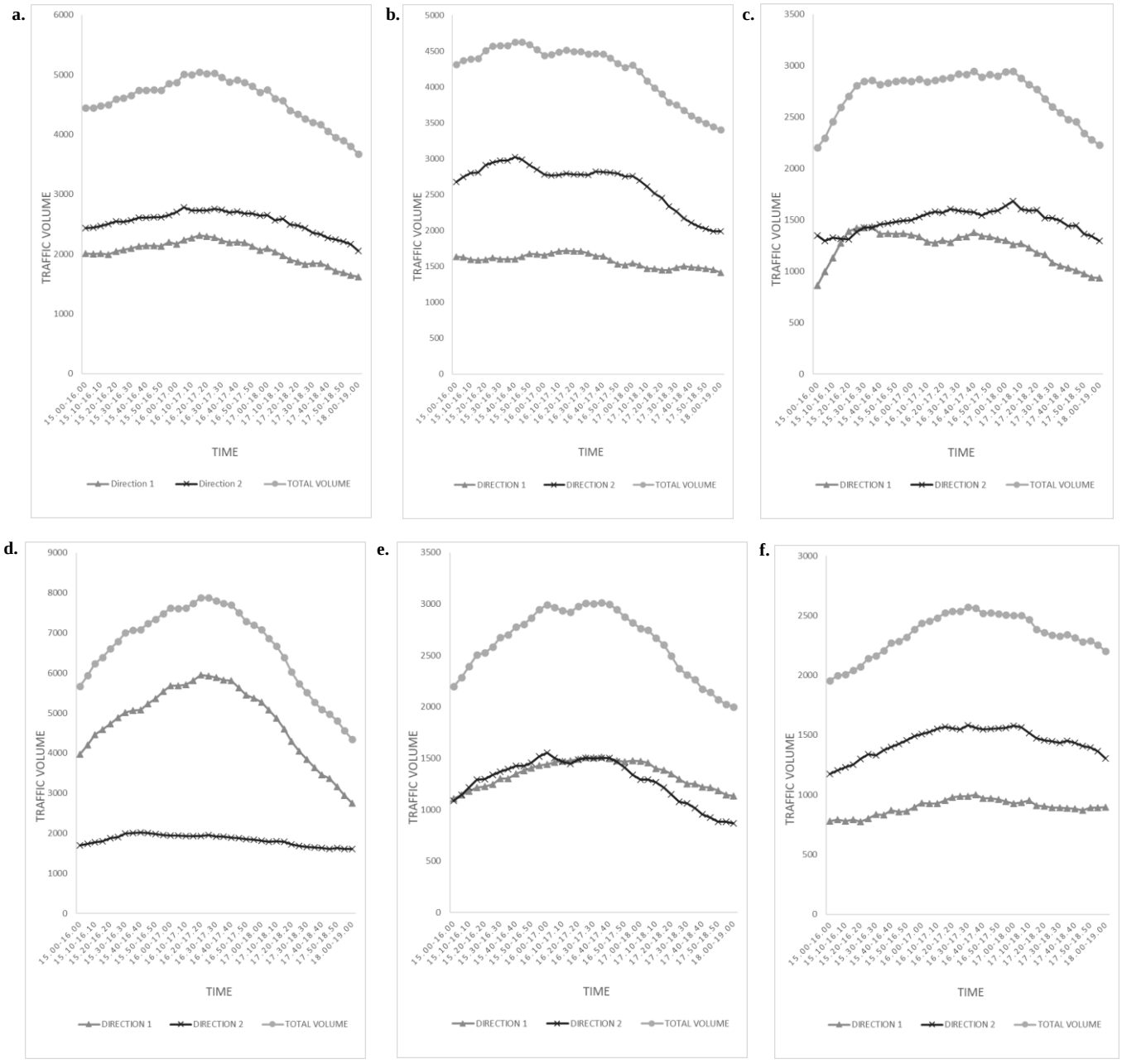

Figure 3. Traffic Volume In The Afternoon Peak Hours (a) on Prapen St. ; (b) on Jemursari St. ; (c) on Jemur Andayani St. ; (d) on Panjang Jiwo St. ; (e) on Kali Rungkut St. ; (f) on Rungkut Industri Raya St.

Based on the results of the analysis of the highest traffic volume in the afternoon on roads in the East Surabaya Area direction 1, On Prapen St. has Traffic Volume 2311 cur/hour at 16.15-17.15 p.m, on Jemursari St. has Traffic Volume 1721 cur/hour at 16.15-17.15 p.m, on Jemur Andayani St. has Traffic Volume 1434 cur/hour at 15.35-16.35.m, on Panjang Jiwo St. has Traffic Volume 5947 cur/hour at 16.20-17.20 p.m, on Kali Rungkut St. has Traffic Volume 16.35-17.35 cur/hour at 16.35-17.35 p.m, and on Rungkut Industri Raya St.has Traffic Volume 1001 cur/hour at 16.35-17.35 p.m. Based on the results of the analysis of the highest traffic volume in the afternoon on roads in the East Surabaya Area direction 2, On Prapen St. has a Traffic Volume of 2778 cur/hour at 16.05-17.05 p.m, on Jemursari St. has Traffic Volume 3025 cur/hour at 15.40-16.40 p.m, on Jemur Andayani St. has Traffic Volume 1638 cur/hour at 17.00-18.00 a.m, on Panjang Jiwo St. has Traffic Volume 2012 cur/hour at 15.40-16.40 p.m, on Kali Rungkut St. has Traffic Volume 1554 cur/hour at 16.00-17.00 p.m, and on Rungkut Industri Raya St.has Traffic Volume 1581 cur/hour at 16.30-17.30 pm.

3.3. Peak Hour Factor

The peak-hour factor (PHF) quantifies the peaking effect, calculated by dividing the hourly volume by the highest flow rate observed in 15 minutes during the peak hour. Calculationally, the peak hour factor is obtained from the total peak hour volume divided by 4 times the volume of the busiest 15 minutes [16]. Peak Hour Factor has a maximum value of 1 (100%) which indicates the maximum capacity is fully loaded. For example, the PHF value is 0.8 (80%), meaning there is still 0.2 (20%) remaining capacity. The greater the PHF value, the closer it will be to the maximum capacity. The Highway Capacity Manual (HCM) suggests congestion in urban areas is 0.92 and rural areas is 0.88. Peak Hour Factor is calculated using equation (2) and equation (3):

$$PHF = \frac{Volume\ jam\ puncak}{tingkat\ arus\ maksimum} \quad (2)$$

For a 15 minute period, the above equation becomes:

$$PHF = \frac{q_{60}}{4 \times q_{15}} \quad (3)$$

Table 4. Volume Description for Each Type of Vehicle on Jemur Andayani St. Every 5 Minutes

Time	Direction 1						Direction 2					
	MC (cur/5 minute)	LV (cur/5 minutes)	HV (cur/5 minutes)	Total	Total Every 15 Minutes	Peak Volume (cur/hour)	MC (cur/5 minutes)	LV (cur/5 minutes)	HV (cur/5 minutes)	Total	Total Every 15 Minutes	Peak Volume (cur/hour)
07.15-07.20	74	63	2	139			83	48	0	131		
07.20-07.25	93	78	1	172	445		102	35	0	137	426	
07.25-07.30	65	66	2	133			104	54	1	159		
07.30-07.35	93	74	4	171			95	32	0	127		
07.35-07.40	76	46	1	123	431		128	24	0	152	411	
07.40-07.45	82	52	4	138		1805	106	27	0	133		1769
07.45-07.50	113	65	1	179			124	58	0	182		
07.50-07.55	69	37	0	106	456		95	45	0	140	466	
07.55-08.00	93	76	2	171			96	47	1	144		
08.00-08.05	104	61	0	165			109	42	0	151		
08.05-08.10	90	81	1	172	473		90	47	1	138	465	
08.10-08.15	72	60	4	136			102	75	0	177		

Based on the analysis results in Table 4, the peak hour volume on Jemur Andayani St. direction 1 is 1805 cur/hour with details of volume every 15 minutes namely 445 cur/15minutes at 07.15-07.30 a.m, 431 cur/15minutes at 07.30-07.45 a.m, 456 cur/15minutes at 07.45-08.00, 473 cur/15minutes at 08.00- 08.15 a.m. The results show the highest 15 minute volume in direction 1, namely 473 cur/15 minutes at 08.00-08.15 a.m. Peak hour volume on Jemur Andayani St. direction 2 is 1769 cur/hour with details of volume every 15 minutes namely 426 cur/15 minutes at 07.15-07.30 a.m, 411 cur/15minutes at 07.30-07.45 a.m, 466 cur/15minutes at 07.45-08.00, 465 cur/15minutes at 08.00- 08.15 a.m. The results show the highest 15 minute volume in direction 2, namely 466 cur/15 minutes at 07.45-08.00 a.m. Analysis of peak hour factor (PHF) on Jemur Andayani St. Direction 1 can be seen in equation (4) and Direction 2 can be seen in equation (5):

$$PHF\ Direction\ 1 = \frac{1805}{4 \times 473} = 0{,}95 \quad (4)$$

$$PHF\ Direction\ 2 = \frac{1769}{4 \times 466} = 0{,}95 \quad (5)$$

Based on the peak hour factor (PHF) analysis results, the peak hour factor (PHF) value on Jemur Andayani St. Direction 1 and Direction 2 is 0.95. This value indicates that when peak conditions occur, the capacity used is 95% of the maximum capacity in directions 1 and 2. The summary of the peak hour factor (PHF) analysis results on the East Surabaya roads can be seen in Table 5 for type 6/ 2 D and Table 6 for type 4/2 D.

Table 5. Analysis of Peak Hour Factor (PHF) for Type 6/2 T in East Surabaya Roads

No.	Road Name	Road Type	Peak Hour Factor (PHF) in Morning Season		Peak Hour Factor (PHF) in Afternoon Season	
			Direction 1 (m)	Direction 2 (m)	Direction 1 (m)	Direction 2 (m)
1	Prapen St.	6/2 T	0,76	0,92	0,88	0,94
2	Jemursari St.	6/2 T	0,96	0,94	0,93	0,94
3	Panjang Jiwo St.	6/2 T	0,85	0,9	0,94	0,97
	Average		0,89		0,93	
	Min		0,76		0,88	
	Max		0,96		0,97	

Table 6. Analysis of Peak Hour Factor (PHF) for Type 4/2 D in East Surabaya Roads

No.	Road Name	Road Type	Peak Hour Factor (PHF) in Morning Season		Peak Hour Factor (PHF) in Afternoon Season	
			Direction 1 (m)	Direction 2 (m)	Direction 1 (m)	Direction 2 (m)
1	Jemur andayani St.	4/2 T	0,95	0,95	0,92	0,9
2	Kali Rungkut St.	4/2 T	0,92	0,94	0,95	0,89
3	Rungkut Industri Raya St.	4/2 T	0,92	0,93	0,94	0,92
	Average		0,94		0,92	
	Min		0,92		0,89	
	Max		0,95		0,95	

Based on the analysis results in Table 5 and Table 6, it shows that the 6/2 D road type has an average peak hour factor (PHF) value in the morning of 0.89 with a value of around 0.76 – 0.96 and in the afternoon it has an average of 0.93 with values around 0.88-0.97. For the 4/2 D road type, the average peak hour factor (PHF) value in the morning is 0.94 with a value of around 0.92 – 0.95; in the afternoon it has an average of 0.92 with a value of 0.89 -0.95. Overall, the average Peak Hour Factor (PHF) value for arterial roads with type 6/2 D is 0.91 with a value of 0.76-0.97 and the average for type 4/2 D is 0.93 with a value of 0.89-0.95.

3.4. Residual Capacity

Residual capacity is the maximum capacity minus the peak hour factor (PHF) value. The maximum capacity value is 1 or 100%. Residual capacity is the capacity that remains when traffic volume reaches a peak. The higher the peak hour factor (PHF) value, the lower the remaining capacity value. Calculation of remaining capacity using equation (6):

$$Residual\ capacity = 100\% - PHF \tag{6}$$

A summary of the residual capacity analysis results on East Surabaya road sections can be seen in Table 7 for type 6/2 D and Table 8 for type 4/2 D.

Table 7. Analysis of Residual Capacity for Type 6/2 T in East Surabaya Roads

No.	Road Name	Road Type	Peak Hour Factor (PHF) in Morning Season		Peak Hour Factor (PHF) in Afternoon Season	
			Direction 1 (m)	Direction 2 (m)	Direction 1 (m)	Direction 2 (m)
1	Prapen St.	6/2 T	0,24	0,08	0,12	0,06
2	Jemursari St.	6/2 T	0,04	0,06	0,07	0,06
3	Panjang Jiwo St.	6/2 T	0,15	0,10	0,06	0,03
	Average		0,11		0,07	
	Min		0,04		0,03	
	Max		0,24		0,12	

Table 8. Analysis of Residual Capacity for Type 4/2 D in East Surabaya Roads

No.	Road Name	Road Type	Peak Hour Factor (PHF) in Morning Season		Peak Hour Factor (PHF) in Afternoon Season	
			Direction 1 (m)	Direction 2 (m)	Direction 1 (m)	Direction 2 (m)
1	Jemur andayani St.	4/2 T	0,05	0,05	0,08	0,10
2	Kali Rungkut St.	4/2 T	0,08	0,06	0,05	0,11
3	Rungkut Industri Raya St.	4/2 T	0,08	0,07	0,06	0,08
	Average		0,07		0,08	
	Min		0,05		0,05	
	Max		0,08		0,11	

Based on the analysis results in Table 7 and Table 8, it shows that road type 6/2 D has an average Residual Capacity in the morning, namely 11% with a value of around 4%-24% and in the afternoon has an average of 7% with a value of around 3%-12%. For the 4/2 D road type, it has an average Residual Capacity value in the morning, namely 7% with a value of around 5% -8% and in the afternoon it has an average of 8% with a value of 5% -11%.

4. Conclusion

The conclusion from this study is that each road section has a peak hour volume (PHV) that varies depending on the amount of traffic volume that passes through the road. Apart from that, the type of road and the time peak volume occurs will differentiate the peak hour factor (PHF) value on a road section. Overall, the peak hour factor (PHF) value for arterial roads in East Surabaya with 6/2 D roads is in the range of 0.76-0.97 with an average of 0.91 and 4/2

roads in the range of 0.89. – 0.95 with an average of 0.93. Based on the results of this study, the peak hour factor (PHF) value can be used as a reference in determining the volume of planned hours in planning a capacity or geometry of roads in the East Surabaya area for 6/2 D or 4/2 D road types.

REFERENCES

[1] de Rozari, A., & Wibowo, Y. H. (2015). Faktor-faktor Yang Menyebabkan Kemacetan Lalu Lintas di Jalan Utama Kota Surabaya. *Jurnal Penelitian Administrasi Publik*, 1(1), 1–5. Retrieved from https://doi.org/10.1007/s13398-014-0173-7.2

[2] Anggraeni, F. A. (2022). Analisis Faktor Yang Mempengaruhi Peningkatan Urbanisasi Di Kota Jakarta Dan Surabaya Pada Tahun 2020-2021. *JURNAL JEBAKU*, 2(2), 41–53.

[3] Anugrah Yulmida, D., Mudjanarko, S. W., Setiawan, M. I., & Limantara, A. D. (2017). Analisis Kinerja Parkir Sepanjang Jalan Walikota Mustajab Surabaya. *Ukarst*, 1(1), 39–46.

[4] Badrujaman, A. (2016). Perencanaan Geometrik Jalan Dan Anggaran Biaya Ruas Jalan Cempaka – Wanaraja Kecamatan Garut Kota. *Jurnal Konstruksi*, 14(1), 25–34. Retrieved from https://doi.org/10.33364/konstruksi/v.14-1.384

[5] Basri Said, L., & Syafey, I. (2021). The scenario of reducing congestion and resolving parking issues in Makassar City, Indonesia. *Case Studies on Transport Policy*, 9(4), 1849–1859. Retrieved from https://doi.org/10.1016/j.cstp.2021.10.004

[6] BPS. (2023). Jumlah Penduduk Menurut Jenis Kelamin dan Kabupaten/Kota Provinsi Jawa Timur (Jiwa), 2021-2023. Retrieved 9 March 2023, from https://jatim.bps.go.id/indicator/12/375/1/jumlah-penduduk-provinsi-jawa-timur.html

[7] Ciont, N., Cadar, R. D., Iliescu, M., & Lasləu, D. A. (2015). Interactive application for the evaluation of the peak hour factor using weigh-in-motion traffic data. *UPB Scientific Bulletin, Series C: Electrical Engineering and Computer Science*, 77(1), 121–128.

[8] Hendrawan, H. (2020). Peak Hour Factor At Urban Road Network System With Fixed Hourly Interval and Moving Hourly Interval (a Case Study At Urban Road in Cimahi City). *Creative Research Journal*, 6(01), 29. Retrieved from https://doi.org/10.34147/crj.v6i01.256

[9] Hidayati, I. (2021). Urbanisasi dan Dampak Sosial di Kota Besar Indonesia, 7(2), 212–221.

[10] Iskandar, H. (2015). Analisis Faktor Jam Sibuk Pada Jalan Luar Kota, 1997(264), 75–86.

[11] Ma, F., Xu, J., Gao, C., & Bi, Y. (2022). Study on the Applicability and Modification of the Design Hourly Volume on Rural Expressways Considering Holiday Traffic Polarization. *International Journal of Environmental Research and Public Health*, 19(16). Retrieved from https://doi.org/10.3390/ijerph19169897

[12] Patel, C. R., & Joshi, G. J. (2012). Capacity and LOS for Urban Arterial Road in Indian Mixed Traffic Condition. *Procedia - Social and Behavioral Sciences*, 48, 527–534. Retrieved from https://doi.org/10.1016/j.sbspro.2012.06.1031

[13] Rahman, M. M., Najaf, P., Fields, M. G., & Thill, J. C. (2022). Traffic congestion and its urban scale factors: Empirical evidence from American urban areas. *International Journal of Sustainable Transportation*, 16(5), 406–421. Retrieved from https://doi.org/10.1080/15568318.2021.1885085

[14] Sabbir, S. M. (2022). Traffic Volume in Dhaka City at Selected Priority Junctions. *Journal of Transportation Engineering and Traffic Management*, 3(1), 1–10.

[15] Sartini Gire, Pandulu, G. D., & Arifianto, A. K. (2019). Evaluasi Tingkat Pelayanan Simpang Tiga Tak Bersinyal pada Simpang Pendem (Jl. Raya Dadaprejo – Jl. Dr. Moh. Hatta – Jl. Ir. Soekarno) Kota Batu. *Prosiding Seminar Nasional Teknologi Industri, Lingkungan Dan Infrastruktur (SENTIKUIN)*, 2, 6.

[16] Wemegah, T. D., Zhu, S., & Atombo, C. (2018). Modeling the effect of days and road type on peak period travels using structural equation modeling and big data from radio frequency identification for private cars and taxis. *European Transport Research Review*, 10(2). Retrieved from https://doi.org/10.1186/s12544-018-0313-9