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Analysis of Traffic Performance Without Signals (Case Study of the Intersection of Jalan Pangeran Antasari-Sumber and Jalan Mertabasah, Cirebon Regency)

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ABSTRACT

Cirebon Regency is a Level II area that has experienced quite rapid traffic growth. Jalan Pangeran Antasari is one of the main roads in Cirebon Regency as a link between districts and is also a road with a fairly dense industrial area. An analysis of the intersection's performance is essential to maintain the level of road service. This paper aims to analyze traffic performance at intersections without signals. The research method was surveying Jalan Pangeran Antasari-Sumber and Jalan Mertabasah, Cirebon Regency, in November 2024—data analysis using the Indonesian Road Capacity Guidelines 2023. The research results on the performance of road sections and intersections indicate the value of vehicle volume obtained. The volume of traffic flow during peak hours on Jalan Pangeran Antasari is 1979 veh/hour or 1534,8 pcu/hour on Monday afternoon. The traffic volume at the unsignalized intersection of Jalan Pangeran Antasari-Sumber – Jalan Mertabasah during peak hours is 2763 veh/hour atau 1647,2 pcu/hour on Monday afternoon. The conclusion is that the capacity level of Jalan Pangeran Antasari was obtained at C = 3640 pcu/hour, Dj = 0,43, and then (LOS) with level B means good. The capacity value of the unsignalized intersection of Jalan Pangeran Antasari-Sumber – Jalan Mertabasah was obtained C= 1647,5 pcu/hour, q= 1643,2 pcu/hour, Degree of Saturation = 0,99 dan Delays at Intersections T= 17,99 sec/drive as well as queue opportunities 39,3% - 77,8%. Thus, the intersection service level obtains Level Of Service E, which means Bad.

1. Introduction

Road infrastructure is developing rapidly, increasing the need for faster transportation and better road access (Nurhasanah, Rifai, Taufik, & Isradi, 2024). Roads are an important land infrastructure to connect various locations such as industrial areas, agribusiness areas, and residential areas, as well as a means of connecting the transportation of goods and services to improve the economic wheels (Purnama, Rifai, & Nasrun, 2022). A good transportation system is crucial to supporting the smooth running of economic and social activities in an area. The most important part of the transportation system is the intersection of roads, which is crucial in organizing traffic flow in an area (Hidayat, Bumulo, & Nento, 2024). Roads are the element that most support the sustainability of transportation facilities equipped with operating systems, traffic management, and transportation procedures. Roads have an important role as a means of transportation to move the community and support economic progress and national stability while helping development stability (Lailatun, Nugroho, Sundari, & Kholis, 2023).

Roads are crucial in the progress of civilization and the wheel of human life because the development of roads and human lives affect each other (Rohmah, 2022). Roads are essential for economic growth and human mobility worldwide (Reta, Rifai, Taufik, & Prasetijo, 2024). Road user safety is an absolute aspect of effective transportation infrastructure management (Kharisma, Rifai, Taufik, & Prasetijo, 2024). Limited maintenance of road infrastructure, the continuous development of transportation technology, and the increasing number of people driving on the road will cause traffic congestion and affect service operations.

Traffic jams and crowds often occur on highways or intersections, especially in the morning and evening, when road users start and end their activities. Traffic jams often occur due to the high accumulation of vehicle currents caused by continuous traffic mixing (Siregar, Paisah, & Hasibuan, 2024). The main factors exacerbating the problem of traffic congestion are the rapid increase in the number of vehicles, the lack of space and resources to build roads, and transportation infrastructure (Citra, Rachman, & Monika, 2020).

Intersections are part of the highway that should be analyzed and described. Capacity analysis or evaluation of intersections is necessary for comparing interchange service levels' characteristics and measures. The level of intersection service has an important impact on the overall smooth flow of traffic (Indriani, Gunawan, Rendi, Permadi, & Saputri, 2024). Intersections are divided into two types of intersections to control traffic drivers: signalized intersections and no-signal intersections. A no-signal intersection is an intersection that does not have a traffic light (Bina Marga, PKJI, 2023). A key factor in determining the right handling in optimizing the intersection function is to analyze the performance of the intersection (Alawiyah, 2024). In contrast to signaled intersections, drivers at unmarked intersections often take less cautious actions, such as overtaking one another. This behavior is largely due to the absence of traffic signs and signals, which can lead to conflicts at these intersections. (Novelia, Pandey, & Lefrandt, 2023).

The intersection of Jalan Pangeran Antasari-Sumber and Jalan Mertabasah is one of the intersection points on the cross-regional route. This road is the center of crowded activities in Lurah Village, Plumbon District, Cirebon Regency. This intersection often experiences congestion because it is located in the industrial area of Jl Pangeran Antasari, Lurah Village. Industrial transport cars such as containers, expedition trucks, and other large vehicles cross this intersection daily. At this intersection, there are also many food vendors or those who use the road. Most customers park their cars on the road, thus narrowing the lane. In addition, Jl Pangeran Antasari is one of the main accesses in the western region of Cirebon Regency to the capital of Cirebon Regency, namely Sumber City. The industrial employees will fill Jl in the morning at the departure time and in the afternoon at the return time. Pangeran Antasari and Jl. Mertabasah. With the high amount of traffic flow from various places, these intersections are no-signal intersections with large vehicle speeds that are often very slow, which will cause traffic jams or buildup. This text serves as a valuable reference for researchers investigating intersections. It emphasizes the analysis of capacity performance for unsignalized intersections utilizing the Indonesian Road Capacity Guidelines (PKJI) 2023. Furthermore, it aims to enhance the operational efficiency of the intersection at Jalan Pangeran Antasari and Jalan Mertabasah in Cirebon Regency.

2. Literature Studies

2.1 Road Characteristics

Travel patterns tend to vary and increase. This impacts the accumulation of traffic flow due to increased flow so that the road accommodates loads that exceed the capacity limit and affects the characteristics of the road (Susilowati & Nugroho, 2022). Road characteristics can be geometric conditions, traffic flow conditions, road geometry, vehicle population, and road medians, as well as side obstacles on the road section due to activities (Sriharyani & Hadijah, 2023). Road geometric design is a way of planning roads that involves calculating angles (Muizz, Rifai, & Fajarika, 2024). Road geometric planning aims to plan safe infrastructure, traffic flow services, and efficient implementation cost utilization ratios (Pramadita & Rifai, 2024). Road geometry has several physical elements, including the shoulder of the road where vehicles stop in emergencies (Rusyadi & Kusumaningsih, 2023). Kerb According to the Researchers (Marasabessy, Ohorella, & Amaheka, 2024). Kerb is the boundary between the road and the pavement. Kerb is usually built parallel to the road, raised above the pavement surface of the road. Drainage functions to drain and organize water disposal (Kurniawan, Khamid, Apriliano,

Imron, & Diantoro, 2023). The road's median reduces conflicts between opposite traffic flows (Widhiastuti & Rahmawati, 2023).

Flow in traffic refers to the accumulation of vehicles that exceed the survey location on a particular road. Measured in-vehicle units per unit of time (veh/hour or pcu/hour). The duration of the observation is usually less than an hour (Presetyanto, 2019). Traffic configuration is one of the factors that change traffic behavior on vehicles (Presetyanto, 2019). Traffic volume is obtained based on the length of observation ≥ 1 hour. Free Flow Speed (FV) is the speed of driving a vehicle without being affected by other vehicles on the road (Bina Marga, MKJI, 1997). Parking on the street is an activity that is often carried out because it is faster and more comfortable for motorists because it can park close to the driver's destination. In urban areas, careless parking is standard. Careless parking is one of the danger factors for road drivers (Rahayu, Rifai, & Fajarika, 2021).

2.2 Intersection

An intersection is the confluence of two or more intersecting streets (Prasetyo, Setiawan, & Pradana, 2022). An intersection is a part of a transportation network with two or more roads that meet, have traffic flows, and are in conflict (Firmansyah, Rifai, & Taufik, 2022). To control it, traffic rules are established. Unsignaled intersections are the meeting places of major roads and rural roads, where vehicles can turn or run without traffic signs. Providing safety instruments is essential to reduce the level of conflict at signaled intersections. So, traffic signs play a vital role in regulating road traffic. If there are no traffic signs, congestion and accidents will occur frequently. Traffic signs should be used at intersections without signals to reduce traffic conflicts (Nur Fatimah & Rifai, 2024).

The impact of traffic congestion can cause losses for motorists. The solution to overcome the problem of traffic congestion is to seek infrastructure improvements, such as widening and adding traffic lanes (Nur Fatimah & Rifai, 2024). In solving the problem of traffic congestion or vehicle queues, it is necessary to pay attention to the route at the intersection to facilitate the movement of vehicles at the intersection (Egan & Rifai, 2024).

2.3 Road Performance

Traffic flow on the road affects the performance of the road itself (Faradila & Puspito, 2022). In Cirebon, precisely at the intersection of Jalan Pangeran Antasari-Sumber and Jalan Mertabasah, the shoulder of the road has been used as a trading location, so there is a traffic queue. Another problem is large vehicle traffic at low speeds, which makes vehicles queue up, and road users who do not want to take turns when entering and exiting intersections. This problem results in suboptimal road performance and inevitable traffic congestion.

Means of transportation need a place to stop. If not properly regulated, it can create a queue for vehicles (Novianto, 2020). With varying traffic flows and road types in certain areas limited, vehicle queues are inevitable. Moreover, the types of vehicles that have the potential to create obstacles must also be considered. According to the clan highway classification system, non-motorized vehicles (KTB) and wheeled vehicles that utilize animal or human power must be taken into account as a separate event in the adjustment factor of side obstacles because the travel time is relatively long and has the potential to create a queue of vehicles that will harm road users (Jayazi, Prasetiawan, & Hadi, 2022).

The theoretical average traffic speed in density is equal to zero or equal to no passing vehicle, called Free Flow Speed. Speed road users are comfortable traveling in environmental, geometric, and traffic conditions, and they are on the road without other vehicles (Ranto, Rumayar, & Timboeleng, 2020). Road capacity in a road system is the maximum accumulation of a vehicle that can cross a road section in the period and normal road and traffic conditions (Punduly, Elvina, & Riani, 2023). The Degree

Of Saturation (*Dj*) will indicate The level of saturation of the traffic trajectory (Ranto, Rumayar, & Timboeleng, 2020).

3. Research Methodology

Before diving into the research thoroughly, preparation is the main key. The preparation begins with the collection of information related to research topics and the preparation of supporting literature. This information is important as a foundation for stepping into the analysis process. The collection of information and planning data is carried out with the aim of obtaining the raw data needed for analysis. Accurate and varied data is required to analyze the condition of Jl Pangeran Antasari and Jl Mertabasah.

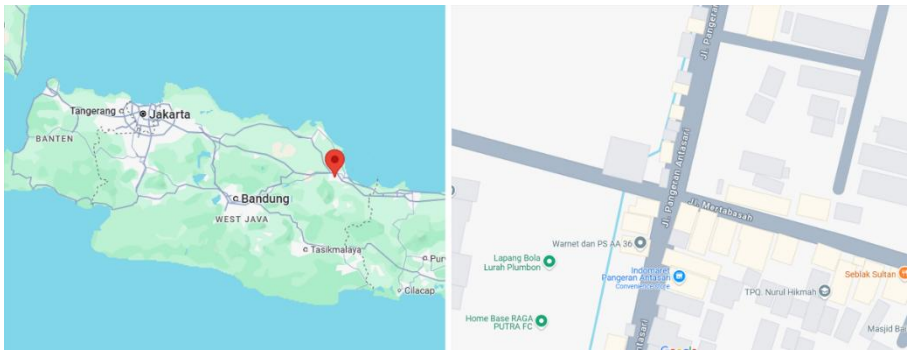

Figure 1. Observation and Research Locations
Source: Google Maps (Accessed October 18, 2024)

The survey was conducted by recording the accumulation of vehicles that crossed the review point at real-time intervals for each type of vehicle. This observation or survey was carried out for one day, namely on Monday, November 25, 2024, during morning rush hours of 08.00 – 09.00 and afternoon rush hours of 16.00 – 17.00. Vehicle Type is recorded every 15 minutes. The survey location is opposite the Cirebon Job Training Center (BLK Cirebon). The research focuses on road geometry and traffic flow using the PKJI 2023 method. The road performance capacity, degree of saturation, delays, and queue opportunities were calculated from the observations made. The results of the analysis can be used as a reference to overcome problems on the road and at the intersection of Jalan Pangeran Antasari-Sumber and Jalan Mertabasah.

4. Results and Discussion

Table 1 Road Geometric Data

Description	Jl. Pangeran Antasari
Type of Road	2/2 TT (2-way undivided two lanes)
Width of Road	7 metre
Roadside	1,5 metre
Road Median	non
Road Contour	Flat
Pavement type	Asphalt

The intersection of Jalan Pangeran-sumber – Jalan Mertabasah is without traffic signals. The road equipment at the intersection is the shoulder of the dirt road without pavement. Road signs use thermoplastic paint; there are signs prohibiting parking on the road from the north of Jalan Pangeran Antasari and signs indicating the intersection from the southbound lane. The existing conditions of the unsignaled intersection of Jalan Pangeran Antasari-Sumber – Jalan Mertabasah are as follows:

Figure 2 Condition of the Intersection of Jalan Pangeran Antasari-Sumber – Jalan Mertabasah
Source: Prepared by the Author & Google Maps (Accessed January 06, 2025)

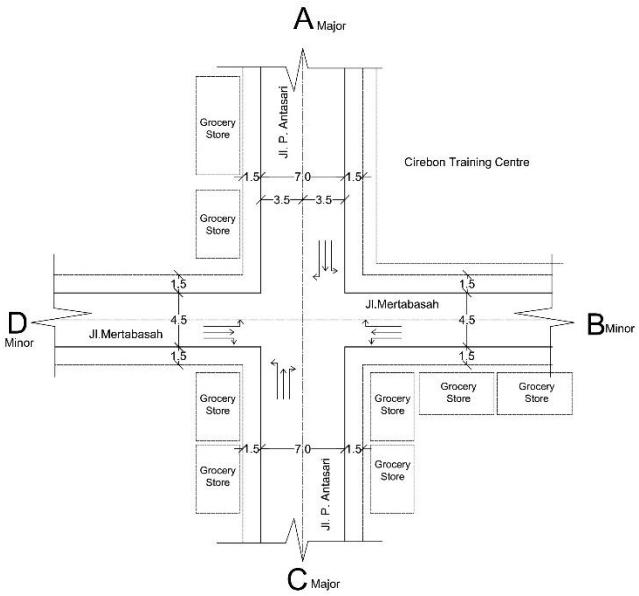

Figure 3 Intersection Geometric Conditions

Based on observations that have been carried out in the section of Jl, Pangeran Antasari. During peak hours, the road section experienced an increase in the number of vehicles, which had an impact on the density of traffic flow. Data will be presented based on the geometric conditions of the road, driver activity, and the facilities available at the intersection. Survey data The traffic volume of the Jalan Pangeran Antasari section was obtained during the highest peak hours on Monday, November 25, 2024, from 16.00 to 17.00. The recapitulation of traffic data during peak hours can be observed in Table 2 below:

Table 2 Traffic Data Recapitulation During Peak Hours

Monday, November 25, 2024 (veh/hour)						
Jl. Pangeran Antasari 07.00-08.00						
Road Segment	MP	KS	BB	TB	SM	Total

Direction North	88	37	5	9	744	883
Direction South	118	52	4	8	784	966
Total 2 direction	206	89	9	17	1528	1849
Monday, November 25, 2024 (veh/hour)						
Jl. Pangeran Antasari 16.00-17.00						
Road Segment	MP	KS	BB	TB	SM	Total
Direction North	84	24	7	6	773	894
Direction South	101	53	5	6	920	1085
Total two direction	185	77	12	12	1693	1979

From observing traffic data, the highest peak hours were obtained on Monday, November 25, 2024, from 16.00 to 17.00, with a total volume in veh/hour as much as 1979. Then, the calculation is carried out using the Indonesian Road Capacity Guidelines 2023 method in Table 3 below :

Table 3 Calculation of Peak Value of Passenger Car Equivalent

	Direction 1						Direction 2					
EMP	**MP**	**KS**	**BB**	**TB**	**SM**	**qdirection1**	**MP**	**KS**	**BB**	**TB**	**SM**	**qdirection2**
	1	1.5	1.6	2.5	0.7		1	1.5	1.6	2.5	0.7	
veh/hour	84	24	7	6	773	894	101	53	5	6	920	1085
pcu/hour	84	36	11.2	15	541.1	687.3	101	79.5	8	15	644	847.5
total	1979	veh/hour	**%direction1**	55	**PA, %=**	55	**Fsmp**	0.78				
	1534.8	pcu/hour	**%direction2**	45								

Based on the calculation results in Table 3, Q_{tot} used on EMP for both directions is 1534,8 pcu/hour. Road capacity regulates road capacity calculation procedures to measure traffic performance and predict urban and out-of-town road design (Azahra, Isradi, Sudrajat, Prasetijo, & Rifai, 2024). The section of Jalan Pangeran Antasari is an out-of-town road; here are the calculations:

$C = C_0 \times FC_L \times FC_{PA} \times FC_{HS}$

$C = 4000 \times 1{,}00 \times 1{,}00 \times 0{,}90$

$C = 3640\ pcu/hour$

Based on the PKJI 2023, the calculation results are derived by dividing the value of the Vehicle volume (pcu/hour) (q) by the capacity value of the road segment (pcu/hour) (C). DJ is the degree of saturation of the street segment, the value of which is less than or equal to 1.00. These results can show whether or not there is a capacity problem in the existing road facilities.

$Dj = q/C$

$Dj = 1534{,}8/3640$

$Dj = 0{,}43$

The value of the service level is assessed based on the degree of saturation (DJ) calculated. The level of service obtained according to Permenhub No.14, The classification of the level road service on the Jalan Pangeran Antasari section studied is B with a value of Dj = 0,43 lower than the saturation degree value of ≤ 1.00.

The total volume of vehicles obtained at the intersection survey was taken for 1 hour each on Monday, November 25, 2024, in the morning and evening.

Table 4 Results of Recapitulation of Simpang Traffic Data

Time	**Monday, November 25, 2024**
	Total (veh/hour)
07.00 – 08.00	2739
16.00 – 17.00	2763

The traffic volume at the intersection during peak hours is Monday at 16.00 – 17.00, which is 2763 veh/hour. This data will be used as a reference in analyzing the intersection capacity. The calculation results can be seen in the Table 5 below :

Table 5 Intersection Traffic Data Calculation on Monday, November 25, 2024 (16.00-17.00)

Traffic Composition (%) :		**MP =**		**KS =**		**SM =**		**K Factor =**			
Pcu factor =		**MP, EMP =**	**1,00**	**KS, EMP=**	**1,30**	**SM, EMP=**	**0,50**	**q_{KB} total**			**q_{KTB}**
Traffic Flow		Veh/h	Pcu/h	Veh/h	Pcu/h	Veh/h	Pcu/h	Veh/h	Pcu/h	R_B	Veh/h
Major Roads from Approach A	qBKi	27	27	12	15.6	264	132	303	174.6	0.337	33
	qLRS	22	22	15	19.5	318	159	355	200.5		46
	qBKa	35	35	10	13	191	95.5	236	143.5	0.277	20
	qtotal	84	84	37	48.1	773	386.5	894	518.6		99
Major Roads from Approach C	qBKi	25	25	12	15.6	241	120.5	278	161.1	0.250	28
	qLRS	45	45	34	44.2	331	165.5	410	254.7		61
	qBKa	31	31	18	23.4	348	174	397	228.4	0.355	57
	qtotal	101	101	64	83.2	920	460	1085	644.2		146
Major Road Total, q_{ma}		**185**	**185**	**101**	**131.3**	**1693**	**846.5**	**1979**	**1162.8**		**245**
Minor Roads from Approach B	qBKi	12	12	8	10.4	177	88.5	197	110.9	0.367	14
	qLRS	11	11	9	11.7	89	44.5	109	67.2		4
	qBKa	13	13	9	11.7	199	99.5	221	124.2	0.411	18
	qtotal	36	36	26	33.8	465	232.5	527	302.3		36
Minor Roads from Approach D	qBKi	21	21	8	10.4	55	27.5	84	58.9	0.331	3
	qLRS	24	24	6	7.8	56	28	86	59.8		3
	qBKa	19	19	8	10.4	60	30	87	59.4	0.334	3
	qtotal	64	64	22	28.6	171	85.5	257	178.1		8
Minor Road Total, q_{mi}		**100**	**100**	**48**	**62.4**	**636**	**318**	**784**	**480.4**		**44**
Total	qBKi	85	85	40	52	737	368.5	862	505.5	0.308	78
	qLRS	102	102	64	83.2	794	397	960	582.2		113
	qBKa	98	98	45	58.5	798	399	941	555.5	0.338	98
$q_{total} = q_{mi} + q_{ma}$ =		**285**	**285**	**149**	**193.7**	**2329**	**1164.5**	**2763**	**1643.2**	**0.653**	**289**

$R_{mi} = q_{mi} / q_{tot} =$	0.284
$R_{KTB} = q_{KTB} / q_{KB} =$	0.105

According to BPS data for Cirebon Regency in 2024, the population of Cirebon Regency is 2,387,961 million people. The data is used as additional data in calculating road and intersection capacity. The capacity of the intersection (C) is calculated by the total incoming flow from all roads at the intersection and is interpreted as the multiplication of the essential capacity (C_0) With a correction factor that calculates the comparison between the variation in ambient conditions and expected conditions (Bina Marga, PKJI, 2023).

$C = C_0 \; x \; F_{LP} \; x \; F_M \; x \; F_{UK} \; x \; F_{HS} \; x \; F_{Bki} \; x \; F_{Bka} \; x \; F_{Rmi}$

$C = 2900 \; x \; 0.895 \; x \; 1 \; x \; 1 \; x \; 0{,}87 \; x \; 0{,}764 \; x \; 1 \; x \; 0{,}955$

$C = 1647{,}5 \; pcu/hour$

Table 6 Intersection Capacity Calculation Results

Options	Base capacity C_0	Traffic Performance							
		Average Approach Width	Major road median	City size	Side obstacle	Turn left	Turn right	Minor /total ratio	Capacity C
	pcu/hour	F_{LP}	F_M	F_{UK}	F_{HS}	F_{Bki}	F_{Bka}	F_{Rmi}	Pcu/hour
1	2900	0,895	1	1	0,87	0,764	1	0,955	1647,5

The degree of saturation can be interpreted as the comparison or ratio of intersection delays between traffic flow and road capacity. The Dj value is an important element in deciding the level of service at the intersection (Isradi, Tarastanty, Dermawan, Mufhidin, & Prasetijo, 2021).

$Dj = q/C$

$Dj = 1643{,}2/1647{,}5$

$Dj = 0{,}99$

The results of calculations related to intersection performance and traffic behavior are presented in the form of Table 7 as follows:

Table 7 Intersections Traffic Performance

Options	Total Traffic Flow q_{total}	Traffic Performance						
		Degree of Saturation	Intersections Traffic delay	Major Road traffic delay	Minor road traffic delay	Intersection geometry delay	Intersection delay	Queuing Opportunity
	Pcu/hour	Dj	T_{LL}	T_{LLma}	T_{LLmi}	T_G	$T = T_{LL} + T_G$	P_a
1	1643,2	0,99	13,99	10,251	23,04	4	17,99	⬆ 77,8% ⬇ 39,3%

From the results of the analysis of existing conditions, the value of (C) = 1647,5 pcu/hour, with (q) = 1643,2 pcu/hour, with a degree of saturation value (Dj) =0,99. This value exceeds the highest limit recommended by PKJI 2023 and should have a DJ score of ≤0.85. The intersection delay value is as

significant as 17,99 sec/pcu. This shows that the Dj score is in category E, which means that the intersection is hampered by low traffic speed, long delays, and ample queue opportunity, which is 39.3% - 77.8%. With the results of the Dj value exceeding the predetermined limit, it is necessary to carry out design engineering and handling so that the intersection's performance can accommodate a more efficient traffic flow.

5. Consclusion

Based on the results of the analysis, it can be concluded as follows:

1. Based on the results of the analysis of the performance of roads and intersections, the vehicle volume values were obtained as follows:
   a. The volume of traffic flow during peak hours or peak hours on Jalan Pangeran Antasari was 1979 vehicles/hour or 1534.8 pcu/hour on Monday afternoon;
   b. The traffic volume at the intersection of Jalan Pangeran Antasari – Jalan Mertabasah during peak hours is 2763 vehicles per hour. On Monday afternoon1647,5 pcu/jam;
2. Based on the analysis of the capacity of the road section and the performance of the intersection, the value of the interchange capacity obtained is as follows:
   a. The capacity level of Jalan Pangeran Antasari was obtained (C) = 3640 pcu/hour. Degree of Saturation (Dj) = 0,43, PKJI-2023 standard ≤1.00. Thus, a service level (LOS) value with level B is obtained.
   b. The capacity value of the intersection of Jalan Pangeran Antasari–Sumber and Jalan Mertabasah was obtained (C) = 1647,5 pcu/hour, with (q) = 1643,2 pcu/hour, with Dj = 0.99, and Intersection Delays (T) = 17,99 sec/veh with intersection service levels based on LOS delays with E level, which means bad. In addition, the chances of queues obtained are pretty large, namely 39.3% - 77.8%.

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