



Available online at
<https://jurnalteknik.unisla.ac.id/index.php/CVL>

<https://doi.org/10.30736/col.v2i2>



CAPACITY ANALYSIS OF DEGREES OF SATURATION OF TRAFFIC TRANSPORTATION (SIGNALIZED INTERSECTION OF ROAD GAJAH MADA - MUNGINSIDI AND RAILWAY BOJONEGORO)

Herta Novianto

Jurusan Teknik Sipil, Fakultas Sains dan Teknik, Universitas Bojonegoro

Email: hertavia2@gmail.com

ARTICLE INFO

Article History :

Article entry : 2024-07-03

Article revised : 2024-08-30

Article received : 2024-09-01

Keywords :

Road Capacity, Degree of Saturation, Traffic Flow Performance

IEEE Style in citing this article:

Herta Novianto, "Capacity Analysis of Degrees of Saturation of Traffic Transportation (Signalized Intersection of Road Gajah Mada - Munginsidi And Railway Bojonegoro)", *civilla*, vol. 9, no. 2, pp. 179–188.

ABSTRACT

Gajah Mada Road and Munginsidi Road in the Bojonegoro district are important roads for the local community. The existence of these various necessary facilities and means will have an impact on the relatively dense traffic volume. Based on the review of the study location and the results of the survey as well as the data collection and processing carried out, the following research results were obtained: The capacity of the Monginsidi Road section is 1,185.52 PCU/hour with a degree of saturation of 0.59, while on the Gajah Mada Road section the capacity of the section roads amounted to 2,836.78 PCU/hour with a degree of saturation of 0.79. Traffic flow performance is determined by the level of road service, the road service level is classified as level C with the description that the flow is stable, but vehicle speed and movement are controlled. On the Gajah Mada Road section, the road service level is classified as level D with the description that the flow is approaching unstable, speed can still be controlled, and Q/C can still be tolerated. To create effective and efficient conditions, namely the realization of orderly, smooth, and comfortable traffic flow, there must be a balance between facilities and facility users so that various traffic problems can be resolved as early as possible.

1. Introduction

One of the problems that often occurs is the dense flow of traffic on roads and intersection areas which often causes congestion at certain periods every urban area, especially in office areas and schools, traffic problems always arise, such as traffic jams and accidents [3] [4], Gajah Mada road and Munginsidi road in the Bojonegoro district are quite important roads for the local community. Gajah Mada road and Munginsidi road, although they have different status roles, on both roads there are various government facilities and necessary facilities for the people of Bojonegoro, including railway tracks and train stations, banks, teaching and learning facilities (schools), shop houses, with various uses, residential areas, shops, kiosks and even markets at certain hours. [5] With the existence of



Copyright © 2024 Herta Novianto. This work is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/). Allows readers to read, download, copy, distribute, print, search, or link to the full texts of its articles and allow readers to use them for any other lawful purpose.

transportation, increasingly better economic, social, and cultural developments will influence the volume of traffic, ultimately influencing and resulting in greater demand for easy, safe, and fast transportation facilities. Long queue due to closure of railway crossing gate on Jalan Laswi Bandung [7]

Congestion that occurs is caused by traffic demand not being proportional to traffic supply, which in this case is the capacity of the roads. Another alternative is to limit traffic demand. This is viewed in terms of the level of traffic generation for land use that utilizes these roads. [8] With such alternatives, land use plan can evaluate the impact of traffic on surrounding roads whose use has been planned or has been built. In this way, it is hoped that the long-term planning of a road network system will be better so that congestion problems can be addressed earlier. [12]

2. Research Method

The research method is a research procedure and technique, and among one study and another, the processes and techniques can differ. The speed survey method (spot-speed) used is using a stopwatch. The survey should be carried out during peak hours and the duration of the study should be one hour or not less than 50 vehicles. The implementation methods in the field are:

- ✓ Determine the observation distance by paying attention to the speed of vehicles passing on the road section being observed
- ✓ Mark the beginning and end of the observation section
- ✓ The stopwatch is turned on when the vehicle passes point A and turned off when the vehicle passes point B.

The time shown by the stopwatch is the vehicle's travel time, while the vehicle speed is the observation distance divided by the travel time. The vehicle speed survey was carried out on Wednesday 13 July 2022.

Secondary data collection includes data on the physical condition of infrastructure in Bojonegoro Regency, which in this case relates to the condition of road feasibility in Bojonegoro Regency obtained from the local BAPPEDA office. Then from DLLAJ, he emphasized that it was based on the laws and regulations in force in Indonesia. The next data accommodates the number of students along Munginsidi road Bojonegoro and others related to this research.

The need for traffic impact studies is addressed in various ways. ITE (Institute of Transportation Engineers) indicates that traffic impact studies are generally determined by the following conditions:

- When new developments are carried out it will generate / add more than the number of trips at certain peak times,
- When development is carried out it will generate more than a certain number of daily trips,
- When the land area becomes larger, rezoning is required,
- When development occurs in volatile areas,
- When the proposed change contains bottleneck areas,
- etc.

ITE stated that the 100 or more additional trips resulting from the development would impact traffic. Rationally it is supported that one hundred vehicles per hour may change the level of service at an intersection approach and left or right turning lanes may be required to accommodate existing traffic without affecting continuous traffic.

Examples of problems that can be discussed in traffic impact analysis are as follows:

- Study components should address issues relating to the specific location, proposed development and existing transport systems,
- The need for a level of accuracy in trip generation estimates,
- If the analysis must include passing traffic and mode choice analysis,
- Selection and evaluation criteria for intersections are based on delay time or intersection capacity utilization,
- Identify areas of influence and analysis of nearby intersections,
- Estimates of air quality and noise impacts,
- Pedestrian and bicycle considerations.

Table 1. The minimum size of land use that requires traffic impact analysis

Land Use	Minimum Area Size
Residential	50 unit
Apartment	50 unit
Office	1,000 m ² building floor area
Shopping Center	50 beds
Hotel / Inn	50 beds
Hospital	10 doctor's offices
Joint Clinic	500 students
School/University	50 students/time
Industrial / Warehouse	2,500 m ² building floor area
Restaurant	100 guests
Meeting Place	100 guests
Terminal	Must
Harbor	Must
Gas Station	4 Nozzles
Workshop	2,000 m ² building floor area
Bank	Must

Source: *Technical Guidelines for Traffic Impact Analysis Department of Transportation, 2015.*

Table 2. Curb adjustment to the road shoulder (FC_{st})

Road Type	Side Friction	Road shoulder adjustment factor with distance to barrier Effectively clear the road shoulder(W _s)			
		≤0.5	1.0	1.5	≥2.0
4/2 split by median	VL	0.96	0.98	1.01	1.03
	L	0.94	0.97	1.00	1.02
	M	0.92	0.95	0.98	1.00
	H	0.88	0.92	0.95	0.98
	VH	0.84	0.88	0.92	0.96
4/2 not separated	VL	0.96	0.99	1.01	1.03
	L	0.94	0.97	1.00	1.02
	M	0.92	0.95	0.98	1.00
	H	0.87	0.91	0.94	0.98
	VH	0.80	0.86	0.90	0.95
2/2 not separated or one way street	VL	0.94	0.96	0.99	1.01
	L	0.92	0.94	0.97	1.00
	M	0.89	0.92	0.95	0.98
	H	0.82	0.86	0.90	0.95
	VH	0.73	0.79	0.85	0.91

Source: *Indonesian Road Capacity Manual (MKJI), 2017.*

3. Description and Technical

Questionnaire Data Processing

1. Mode used to get to school

The movement of students to their respective schools uses various available modes. Based on the results of a survey conducted, it is known that car mode is 3.4%, motorbike mode is 85.6%, while public transport is only 1.4%, this shows that only a few students use public transport. Public transportation is now less popular because students prefer to use motorbikes which have relatively high movement and mobility with relatively economical fuel and are very easy for the public to own, of course, parents of students who facilitate their children with motorbikes. credit method for leasing provided by the dealer. The majority of non-motorized vehicles, namely bicycles and pedicabs, are used by students from MTsN Bojonegoro because they are under adult age so they are limited to using other modes.

Table 3. The mode used by Students

Moda	Jumlah	Prosentase %
Car	12	3.4
Motorcycle	304	85.6
Public transportation	5	1.4
Non-Motorized Vehicles	34	9.6
Total	355	100

Source: Survey Results July 11 2022.

2. Distance and time to go to school

The distance between students from home to their respective schools varies. The survey results showed that the distance from home (home base) to each school was 64.8%, distance < 10 km, 30.4%, distance 11 - 20 km, 4.2%, distance 21 - 30 km, and distance > 30 km only 0.6%. From the survey results, it can be seen that the majority of students' distance to school is < 10 km, which means that these students live in the city or around the city. In the future, this will affect the meeting point for many road users, because the average departure time for students who live in the city is at the highest peak hour.

Table 4. Distance traveled by Respondents / Students

Distance	Amount	Percentage %
< 10 km	230	64.8
11 - 20 km	108	30.4
21 - 30 km	15	4.2
> 30 km	2	0.6
Total	355	100

Source: Survey Results July 11 2022.

Table 5. Student/Respondent departure time

Departure time	Jumlah	Prosentase %
05.30 – 06.00 WIB	28	7.9
06.01 – 06.30 WIB	93	26.2
> 06.30 WIB	234	65.9
Total	355	100

Source: Survey Results July 11 2022.

3. Collection and processing of traffic data on road sections

Road traffic at the triple intersection of Monginsidi road - Gajah Mada road is mixed traffic, namely regional traffic and local traffic which can be grouped into types of heavy vehicles (HV), including two-axle trucks, three-axle trucks, articulated trucks, trailers and bus. Types of light vehicles (LV) include sedans, station wagons, pick-ups, jeeps, minibuses and city transportation, motorbikes (MC) and non-motorized vehicles (UM). Field data from each type of vehicle is calculated for each observation period, namely 15 minutes, while the existing condition of Jalan Monginsidi is 1,512 m long and the road width is 5 m, 2 lanes without a median and shoulders.

The traffic survey was carried out for three days, namely 11 to 13 July 2022 at peak hour with two observation sessions. The first observation session was carried out when students left for school, with a time allocation of 06.00 – 08.00 WIB. The second observation session was carried out at 13.00 – 15.00 WIB, which is the allocated time for students to return home from school.

The survey location was carried out on the Monginsidi road section at a distance of 300 meters south of the three intersection points of Monginsidi road - Gajah Mada road which is the way for students to go to school.

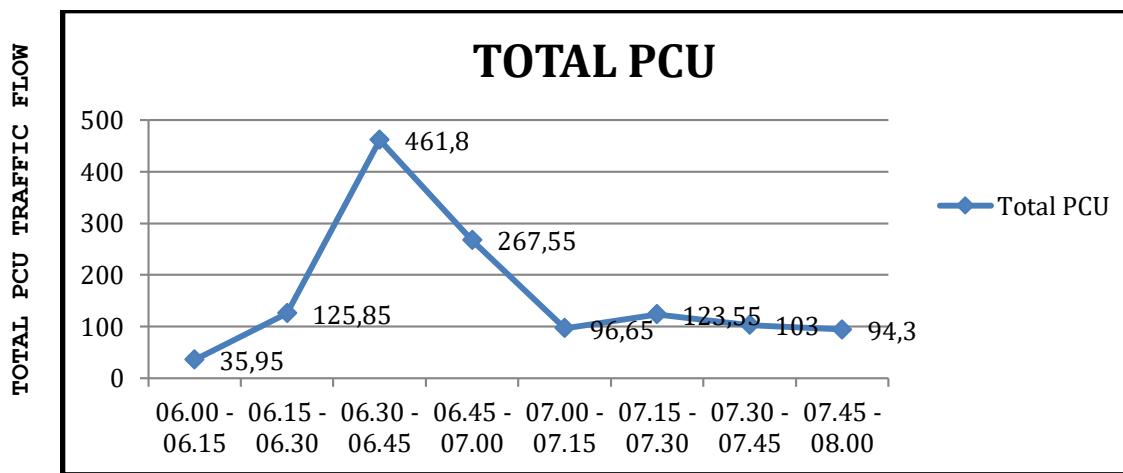
In conducting traffic volume surveys, a survey of side obstacles is also needed to determine the types of side obstacles which are calculated including the number of pedestrians, the number of parked or stopped vehicles and the number of vehicles moving slowly. This happens due to factors related to the activity of Krempyeng Market, city transportation and trains at certain times and has the potential to cause traffic jams for some time.

Traffic volume data during the observation period is arranged in tabular form with the arrangement of the traffic volume survey results using vehicle units. The data on the number of vehicles obtained is then processed according to the equation/conversion explained in chapter 2 by converting the number of vehicles into passenger car units to make it easier for subsequent calculations. The research was conducted on active days, namely facultative effectiveness for students around the study location. The traffic volume survey was carried out on July 11 2022. To make it easier to see the results of this data collection, you can see the recapitulation of traffic volume data that has been collected from the study location as follows.

Table 6. Traffic Volume on Monginsidi Road during School Departure Hours

Time Period per 15 minutes	Number of vehicles			Total PCU
	LV	HV	MC	
06.00 - 06.15	11	3	61	35.95
06.15 - 06.30	9	2	327	125.85
06.30 - 06.45	14	1	1.276	461.8
06.45 - 07.00	18	0	713	267.55
07.00 - 07.15	12	2	235	96.65
07.15 - 07.30	9	3	317	123.55
07.30 - 07.45	10	4	252	103
07.45 - 08.00	19	5	198	94.3
Total	102	20	3,379	1,308.65

Source: Survey Results July 2022.



Source: Survey Results July 2022.

Figure 1. Graph of Fluctuations at JL Monginsidi Middle School during School Leaving Hours

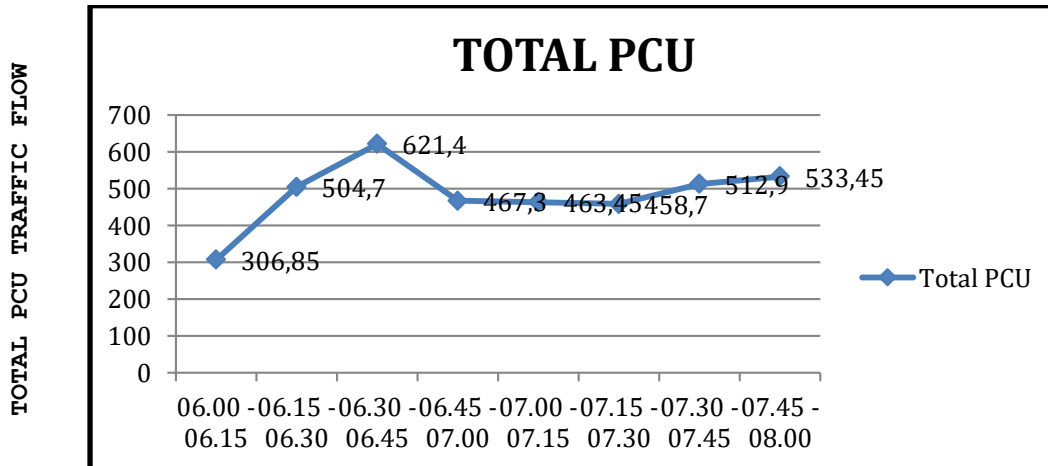
The survey on Jalan Gajah Mada was carried out on July 12 2022 with an observation point at the location of the road intersection. The implementation time still uses Peak Hour time so that the comparison of traffic volume at that hour on both road sections can be seen.

Table : 7 Traffic Volume on Jalan Gajah Mada during School Departure Hours

Time Period per 15 minutes	Number of vehicles			Total PCU
	LV	HV	MC	
06.00 - 06.15	61	8	675	306.85
06.15 - 06.30	108	15	1082	504.7

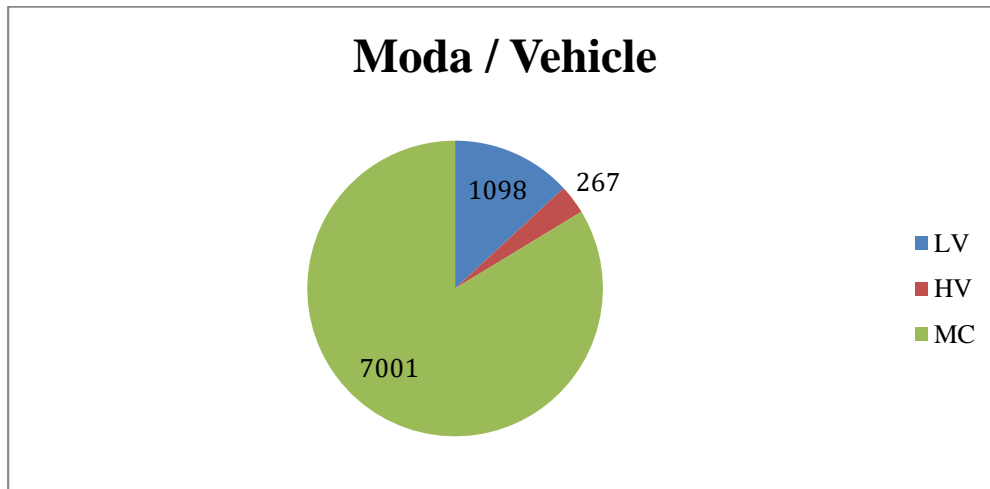
06.30 - 06.45	112	43	1308	621.4
06.45 - 07.00	165	11	826	467.3
07.00 - 07.15	92	52	883	463.45
07.15 - 07.30	197	39	614	458.7
07.30 - 07.45	164	51	822	512.9
07.45 - 08.00	199	48	791	533.45
Total	1,098	267	7,001	3,868.75

Source: Survey Results July 2022



Source: Survey Results July 2022.

Figure 2. Fluctuation graph of Jalan Gajah Mada Middle School during school departure times



Source: Survey Results July 2022.

Figure 3. Recapitulation diagram of traffic volume on Gajah Mada road during school departure hours

The percentages in the diagram above are Light Vehicles (LV) 13%, Heavy Vehicles (HV) 3% and Motorcycles (MC) 84%.

4. Results and Discussions

The calculation results of the intersection approach capacity are then used to calculate the degree of saturation (DS) at the intersection approach. The value of DS indicates whether the road segment has capacity problems or not. The degree of saturation is formulated in equation 2.5 as follows:

$$\begin{aligned}
 DS_{\text{Monginsidi}} &= \frac{Q}{C} \\
 &= \frac{271,4}{287,78} = 0.94 \\
 DS_{\text{Gajah Mada Barat}} &= \frac{Q}{C} \\
 &= \frac{573,3}{776,06} = 0.74 \\
 DS_{\text{Gajah Mada Timur}} &= \frac{Q}{C} \\
 &= \frac{806,8}{941,18} = 0.86
 \end{aligned}$$

Table 8. Intersection Approach Capacity (C) and Degree of Saturation (DS) at the Monginsidi Road - Gajah Mada Road Bojonegoro Intersection

Approach Type	Approach Capacity (PCU/hour)	Degree of Saturation
Monginsidi	287.78	0.94
Gajah Mada Barat	776.06	0.74
Gajah Mada Timur	941.18	0.86

Source: Survey Results July 2022.

In connection with the presence of railway crossings near the intersection, the results of the survey show that vehicles stopped when the train passed can be seen in table 8 as follows:

Table : 9

A number of vehicles were stopped on both lanes of Jalan Monginsidi due to a passing train

The clock passed	Enter			Jalan Monginsidi Out				
	LV	HV	MC	Total SMP	LV	HV	MC	Total SMP
06.30	0	0	41	14.35	4	0	37	16.95
07.30	0	0	27	9.45	3	1	22	11.9
13.15	2	0	36	14.6	2	2	38	17.7
13.20	1	1	29	12.35	3	1	32	15.4
13.30	1	0	25	9.75	2	0	46	18.1
13.45	2	1	43	18.25	3	0	48	19.8
14.30	2	0	25	10.75	1	2	53	21.95
Total	8	2	226	89.5	18	6	276	121.8

Source: Survey Results July 2022.

From Table 9 above, it can be seen that the total number of vehicles stopped due to passing trains with an average duration of 3 minutes until the barrier opens again. The number of vehicles stopped in both entry and exit lanes on Jalan Monginsidi is 211.3 PCU/21 minutes = 73.95 PCU/hour.

With train activity during rush hour which causes vehicles to stop, of course, the traffic flow (Q) value at the Jalan Monginsidi approach will jump from 271.4 PCU/hour to 345.35 PCU/hour which is obtained from the additional value of stopped vehicles of 73.95 PCU/hour so that it will change the value of the degree of saturation at the Jalan Monginsidi approach.

Table 10. Intersection Approach Capacity (C) and Degree of Saturation (DS) at the Monginsidi Road Approach due to activity from the Train

Total Current(Q)	Capacity (C)	Degree of Saturation (DS)
345.35	287.78	1.2

Source: Survey Results 2022

With a degree of saturation value > 0.85 in the MKJI, it is stated that the intersection is approaching over-saturation, which will cause long queues at peak traffic flow conditions.

5. Conclusion and Suggestion

5.1 Conclusions

Based on the data collection and processing and data analysis that has been carried out, several conclusions can be drawn, namely as follows:

1. The capacity of the Monginsidi road section is 1,185.52 PCU/hour with a degree of saturation of 0.59, while on the Gajah Mada road section the capacity of the road is 2,836.78 PCU/hour with a degree of saturation of 0.79. Traffic flow performance is determined by the level of road service, namely on Jalan Monginsidi the road service level is classified as level C with the description that the flow is stable, but vehicle speed and movement are controlled. On the Gajah Mada road section, the road service level is classified as level D with the description that the flow is approaching unstable, speed can still be controlled, and Q/C can still be tolerated.
2. The presence of train activity on the Monginsidi road section will increase the value of the degree of saturation in the capacity approaching Monginsidi road which results in long queues and the danger of vehicle fumes. To create effective and efficient conditions, namely the realization of orderly, smooth, and comfortable traffic flow, there must be a balance between facilities and facility users so that various traffic problems can be resolved as early as possible.

5.2 Suggestions

Based on the results of the analysis and discussion above, it is recommended, among others:

- a. Seeing the existing conditions around the section of Monginsidi road near the intersection, the Bojonegoro Regency Government through SATPOL PP has requested the wisdom to control kiosks or stalls and relocate the Krempyeng Market activities.
- b. We ask for the wisdom of the Public Works Department to consider closing the water/sewer channels as an alternative to increasing the width of Monginsidi road.
- c. Considering the importance of road markings, it is recommended that the relevant agency, namely the LLAJ Service, improve the road markings on Monginsidi road so that they are clearer in the hope that road users can position themselves in traffic correctly.
- d. Based on the culture of undisciplined road users, it is appropriate for the LLAJ and SATLANTAS Services to provide strict sanctions for violators/road users who are not disciplined in traffic.
- e. The high value of the degree of saturation, which is a measure of the stability of traffic flow at both intersection approaches, requires resetting of the intersection signal times by the LLAJ Service.

References

- [1] Jasti, P. C., & Ram, V. V. (2016). Integrated and Sustainable Service Level Benchmarking of Urban Bus System. *Transportation Research Procedia*, 17, 301–310. <https://doi.org/10.1016/J.TRPRO.2016.11.096>
- [2] Angelina, S., Vallée, D., & Louen, C. (2018). The barriers in the implementation process and the operation of innovative Urban transport: The case of BRT Jakarta. *WIT Transactions on the Built Environment*, 176, 69–80. <https://doi.org/10.2495/UT170071>
- [3] Tomtom Traffic Index. (2021). Traffic Index Traffic Index results 2018 - 2021. [Www.Tomtom.Com.https://www.tomtom.com/traffic-index/ranking/](http://www.tomtom.com/traffic-index/ranking/)

- [4] Nova Nevila Rodhi, Risk Analysis of Surabaya – Bojonegoro Highway Improvement Project Based on Fuzzy Logic, *Jurnal Teknik Sipil Universitas Islam Lamongan*, Volume 07 Number 1 Year 2022
- [5] Sinha, S., Sadhukhan, S., & Priye, S. (2017). The Role of Quality Assessment for Development of Sustainable Bus Service in Mid-sized Cities of India: A Case Study of Patna. *Procedia Engineering*, 198, 926–934. <https://doi.org/10.1016/J.PROENG.2017.07.138>
- [6] Koike, H. (2014). Mobility perspective for a local city in Japan. *IATSS Research*, 38(1), 32–39. <https://doi.org/10.1016/J.IATSSR.2014.05.006>
- [7] Jia, S. (2021). Collaborative Strategies and Multiple Performances of Haze Pollution Control: A Case Study of Motor Vehicles. *Arabian Journal for Science and Engineering*, 46(2), 1631–1646. <https://doi.org/10.1007/S13369-020-04846-3>
- [8] Ambarwati, L., Indriastuti, A. K., Devia, Y. P., & Sari, D. N. (2017). Can the design of space-transport development strategies influence on noise pollution? *MATEC Web of Conferences*, 138. <https://doi.org/10.1051/MATECCONF/201713807017>
- [9] H. Canakci, M. Hamed, F. Celik, W. Sidik, and F. Eviz, “Friction characteristics of organic soil with construction materials,” *Soils Found.*, vol. 56, no. 6, pp. 965–972, 2016. *Media Komunikasi Teknik Sipil*, 20(2), 125–133.
<https://doi.org/10.12777/mkts.20.2.125-133>
- [10] Badan Pusat Statistik. (2020). Perkembangan Jumlah Kendaraan Bermotor Menurut Jenis. [Www.Bps.Go.Id](http://www.bps.go.id).
- [11] H. G. Ghazaryan, S. Z. Kroyan, S. V. Tovmasyan, and R.-V. H. Margaryan, “The issue of usage and preservation of soils which will be covered by water due to the construction of Kaps reservoir of the Republic of Armenia,” *Ann. Agrar. Sci.*, vol. 16, no. 3, pp. 362–365, 2018. *International Journal of Water Resources Development*, 36(5), 839–854.
<https://doi.org/10.1080/07900627.2019.1568232>
- [12] IESR. (2019). Sektor Transportasi Menjadi Penyumbang Emisi GRK Indonesia Terbesar Kedua Setelah Sektor Industri. <https://iesr.or.id>. <https://iesr.or.id/infografis/sektor-transportasi-menjadi-penyumbang-emisi-grk-indonesia-terbesar-kedua>
- [13] Denicolo, P., Long, T., & Bradley-Cole, K. (2021). Data analysis, meaning interpretation and management/presentation issues. *Constructivist Approaches and Research Methods: A Practical Guide to Exploring Personal Meanings*, 131–154.
<https://doi.org/10.4135/9781526402660.n10>
- [14] Ding, C., & Song, S. (2012). Traffic Paradoxes and Economic Solutions. *Journal of Urban Management*, 1(1), 63–76. [https://doi.org/10.1016/S2226-5856\(18\)300542](https://doi.org/10.1016/S2226-5856(18)300542)
- [15] D. Lin, X. Yang, and C. Gao, “VISSIM-based Simulation Analysis on Road Network of CBD in Beijing, China,” *Procedia Soc Behav Sci*, vol. 96, 2013, doi: 10.1016/j.sbspro.2013.08.054.
- [16] Bucek, “Pertigaan Jalan Sultan Alauddin - AP Pettarani Macet Parah,” *Celebes Media*. [Online]. Available: <https://celebesmedia.id/celebes/artikel/1009050322/pertigaan-jalan-sultan-alauddin-ap-pettarani-macet-parah>

- [17] Y. Oktopianto, W. Y. Hastuti, and R. Phahlevi Marwanto, "Traffic Accident Cost Analysis Using The Gross Output (Human Capital) Method Approach," *Civilla : Jurnal Teknik Sipil Universitas Islam Lamongan*, vol. 9, no. 1, pp. 1–10, 2024, doi: 10.30736/cvl.v9i1.1169.
- [18] A. Sahri, E. Purwanto, and A. Budiharjo, "Kajian Manajemen Lalu Lintas Kawasan Central Business District (CBD) di Kota Tegal," vol. 8, no. 1, pp. 38–52, 2021, doi: 10.46447/ktj.v8i1.291.
- [19] H. A. Apriawal, "Tugas akhir evaluasi kinerja simpang tiga tak bersinyal di kota makassar," 2019.
- [20] S. Hadi, S. A. R. Hanida, and R. Aprianto, "JURMATEKS Peningkatan Kinerja Simpang Ciceri , Kota Serang dengan Model," vol. 7, pp. 1–13, 2024, doi: 10.30737/jurmateks.v7i1.5619.