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Impact Analysis of Vehicle Load and Average Daily Traffic on Damage to Siliwangi Highway Roads Bekasi STA 0+000 - 1+800 Using SPSS and AASHTO Method

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ABSTRACT
The damage on the Bekasi Siliwangi road is suspected to be caused by the large number of heavy vehicles passing through the road. The purpose of this study was to analyze the effect of daily traffic and vehicle load on the damage to Jalan Raya Siliwangi Bekasi. From thr calculation in this study, we can know that the Truck Factor value on the Siliwangi road from the Narogong direction to the Cut Meutia direction is 4.008 which is larger than 1 and truck factor value on the Siliwangi road from the direction of Cut Meutia to the direction of Narogong is 4.403 which is larger than 1. This indicates that road damage is caused by traffic load factors. Based on the results of the R Square test R Square value is 0.539 and 0.924, thus it can be said that daily traffic affects road damage by 53.9% and 92.4%. Based on the results of the t test between vehicle volume and road damage on highway Siliwangi Bekasi from Narogong to Cut Meutia road it is known that: The calculated t value of vehicle volume is 2,858 with Sig 0.024 and the other road section is 6,965 with Sig 0.02 we can conlude that the vehicle volume is greater than t table and the significant level of t calculated vehicle volume is less than 0.05, it can be interpreted that vehicle volume has a significant effect on road damage.

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1. INTRODUCTION

According to Salim in Sugianto and Kurniawan [1] Transportation is the activity of moving goods and passengers from one place to another. Transportation can be defined as the business and activity of transporting or carrying goods and/or passengers from one place to another. Transportation cannot operate if it is not supported by transportation facilities and infrastructure, and one of the transportation infrastructures is roads [2]. Roads are land transportation infrastructure which includes all parts of the road, including complementary buildings and equipment intended for traffic, which are on the ground surface, above the ground surface, below the ground and/or water surface, and above the water surface, except for roads. trains, lorries and cableways [3].

The function of roads in general is as a means of connecting between regions or regions, opening access to certain areas and playing a role in the smooth movement of people and goods [4]. Based on the binding material, road pavement layers are divided into two categories, namely flexible pavement layers and rigid pavement layers. Flexible pavement is a pavement that uses asphalt as a binder. Rigid pavement is a pavement that uses Portland cement as a binder [3].

The Siliwangi road section is an access road located in the city of Bekasi, which is heavily trafficked, with lots of trucks transporting goods or containers, buses and other heavy vehicles passing through this route. This road section includes a 2-lane road, so this condition often causes traffic jams and overloads resulting in this road being damaged quickly and not in accordance with the age of the pavement plan. In general, roads will experience a decrease in their structural function as they age, moreover they are too often crossed by trucks

whose loads do not match their capacity. Roads are currently experiencing a lot of pavement damage in a very short time (early damage) either newly built or newly repaired (overlay) roads.

There is a lot of overloads on the road due to disobedience to the rules and lack of supervision on the weighbridge against the load of vehicles passing through the road. A significant impact caused by overloading that must be considered is road damage before the design life is reached. The road class based on the function and traffic intensity as well as the carrying capacity of receiving the axis load of the dimensions of motorized vehicles is the content of Law Number 79 of 2013 concerning the traffic network and road transportation in Article 17 paragraph 1 it is stated that class III roads as referred to include arterial roads, collector roads. , local and environmental.

2. LITERATURE REVIEW

2.1. Definition of Highways

There are several definitions of the road, namely:

1. Government Regulation Number 34 of 2006: According to Government Regulation Number 34 of 2006, a road is a land transportation infrastructure covering all parts of the road, including auxiliary buildings and equipment intended for traffic, which are on the ground surface, above ground level, above water level and below ground level. and or water, except for railroads, lorry roads and cable roads [15].
2. RI Law No. 22 of 2009 concerning traffic and transportation : According to RI Law No. 22 of 2009 concerning road traffic and transportation, a road is defined as all parts of the road, including auxiliary buildings and equipment intended for public traffic, which are at ground level, above ground level, below ground level and water, as well as above the surface of the water, except for railroads and cable roads.
3. Siddik and Agus: Land transportation (roads and rail-based roads) is the movement of people, vehicles and goods from one place to another using a road network.
4. Clarkson H. Oglesby: According to Clarkson H. Oglesby in Matwear and Rokhman (2019) highways are dirt paths above the earth's surface made by humans with the shape, size and type of construction so that they can be used to channel the traffic of people, animals and vehicles transporting goods from one place to another easily and quickly [16].

2.2. Vehicle Traffic Factor

The vehicle equivalent value in this calculation analysis is based on the equivalent normal load from the Bekasi Highways Public Works data. The calculation of the equivalent value can be seen in the table below.

Table 1. AE value data on normal road conditions.

No.	Vehicle Type			Total Weight (Tons)	Axle Load Configuration (Tons)					AE value
	Transportation type	Group	Axis Configuration		Front Wheel	Rear Wheel				
					ST, RT	Number 1	2nd	The 3rd	To 4	
1.	Sedans, Jeeps	2	1.1	4	2.00	2.00				0.0376
2.	Pick up, micro truck	3	1.2	5	2.04	2.96				0.0396
3.	2 Axle Truck (L)	4	1.2	13	4.42	8.58				1.6708
4.	Small Bus	5a	1.2	6	2.04	3.96				0.0747
5.	Big Bus	5b	1.2	9	3.06	5.94				0.3839
6.	2 Axle Truck (H)	6	1.2	15,15	5.15	10.00				3.0826
7.	3 Axle Truck	7a	1.2.2	25	6.25	9.38	9.38			4,1970
8.	4 Axle Truck	7b	1.2+2.2	31.40	5.65	8.79	8.48	8.48		4.4854
9.	Semi-Trailer Truck	7c	1.2.2+2.2	45	5.85	18.00	7.05	7.05	7.05	4.9931

2.3 Vehicle Volume Data

Vehicle volume is the number of vehicles that cross a road flow in a certain period measured in units of vehicles per unit time. In this study, to determine the number of vehicles crossing Jalan Raya Siliwangi Bekasi, researchers made direct observations of Jalan Raya Siliwangi Bekasi in the direction of Narogong to Cut Meutia and the direction of Cut Meutia to Narogong using a stopwatch, survey form and multi counter (an android application to count the number of vehicles). The following data obtained through the survey are presented in the table below, and to calculate SMP/Hours are Number of vehicles X the equivalent value of vehicles.

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Table 2. Data for Highway Vehicle Volume Siliwangi, Bekasi.

Date and time	Direction	Total Vehicle Volume
Monday, August 1, 2022	Cut Meutia to Narogong	19590,65
	Narogong to Cut Meutia	21547,4
Wednesday, August 3, 2022	Cut Meutia to Narogong	20411,55
	Narogong to Cut Meutia	22492,9
Friday, August 5, 2022	Cut Meutia to Narogong	11768,45
	Narogong to Cut Meutia	13017
Sunday, August 7, 2022	Cut Meutia to Narogong	12036,65
	Narogong to Cut Meutia	13253

3. METHOD

3.1. Overview of Research Locations

Siliwangi Street is one of the roads in Bekasi City, precisely in Rawa Lumbu District, Bekasi City. This road is undergoing widening and asphalting in 2020. Siliwangi Road is the primary arterial road that connects Narogong Street with Cut Meutia Street. Primary arterial roads are roads that effectively connect between national activity centers or between national activity centers and regional activity centers (Saputra, 2022). Jalan Siliwangi Bekasi has a length of 2 km and a width of 13.6 meters which is divided into two directions, where each direction consists of a lane.

The road segment used in this study is the 1.8-meter-long Siliwangi Bekasi road, starting from the red light at the T-junction of Siliwangi Street and Cut Meutia Street. The road section used in this study is divided into 9 STAs where each STA has a length of 200 meters. The images of the roads used in this study can be seen in the image below.

Figure 1. Jalan Siliwangi Bekasi STA 0+000 to STA 1+800.

Based on the distribution of STA above, the researcher divides Jalan Siliwangi into 9 segments which are adjusted to the number of STAs. The segments are:

1. Segment I which is between STA 0+000 and STA 0+200
2. Segment II which is between STA 0+200 and STA 0+400
3. Segment III which is between STA 0+400 and STA 0+600
4. Segment IV which is between STA 0+600 and STA 0+800
5. Segment V which is between STA 0+800 and STA 1+000
6. Segment VI which is between STA 1+000 and STA 1+200
7. Segment VII which is between STA 1+200 and STA 1+400
8. Segment VIII which is between STA 1+400 and STA 1+600
9. Segment IX which is between STA 1+600 and STA 1+800

3.2. Road Geometric Data

It is carried out by direct observation and measurement along the 1.8 KM Jalan Raya Siliwangi section, starting from the fork in the Cut Meutia road towards Narogong. This measurement was carried out along the

research location and observations of traffic facilities were carried out along the research location. The following data obtained through the survey are presented in the table below:

Table 3. Geometric data of research location.

1	Road Type	National road
2	Road Segment Length	1.8 Km
3	Alignment Type	Flat
4	Road markings	There is
5	Lighting	There is

Table 4. Road width.

No	The width of the road	Size
1	Cut Meutia Directions - starting point - endpoint	 - 6.8 m - 6.8 m
2.	Narogong Direction - Starting point - Endpoint	 - 6.8 m - 6.8 m
3	Median	1 ms

3.3. Research Flow

Below is a suggested flowchart for this research to illustrate the process of this research. The data collection process starts with a site survey, as well as secondary and primary data collection after which the data is processed and analyzed, and results and conclusions are obtained.

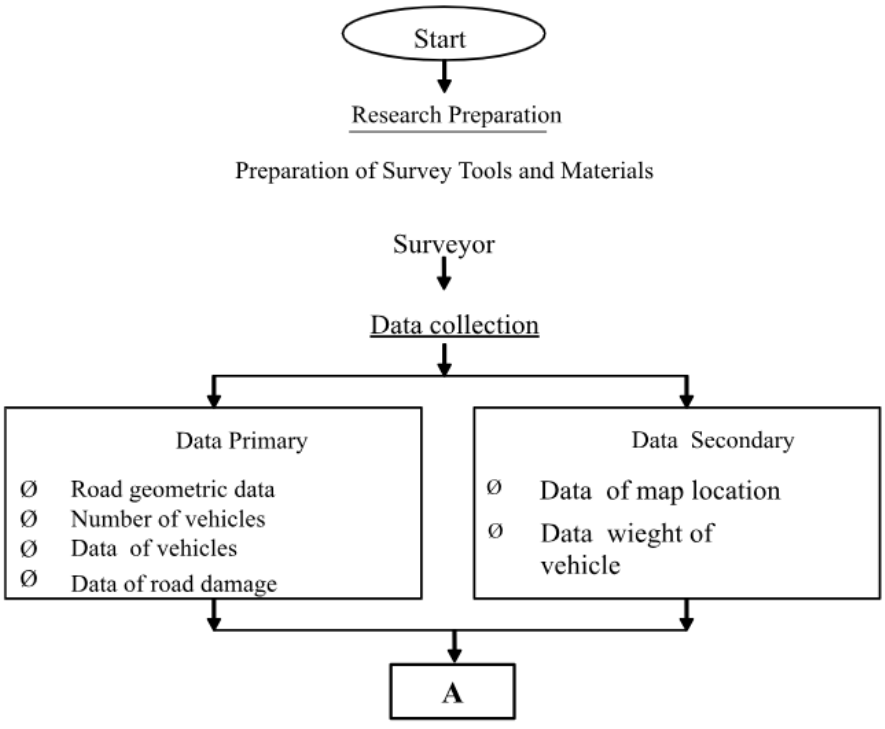

Figure 2. Research flowchart.

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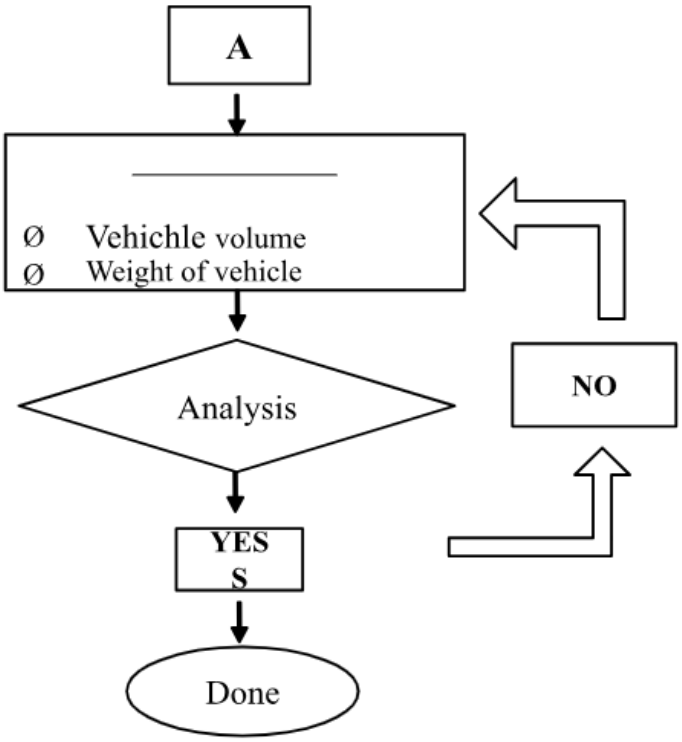

Figure 2. Research flowchart (continue).

3.4. Data Collection Technique

The primary data in question is road damage data, road geometry and vehicle traffic data (LHR) that cross Jalan Raya Siliwangi Bekasi from 2 road directions, the direction of Narogong towards Cut Meutia and the direction of Cut Meutia carried out 4 days starting from August 1 2022 and finished on August 7, 2022. The time set for conducting the survey:

1) Monday at 06.00 WIB – 19.00 WIB (1 August 2022)
2) Wednesday at 06.00 WIB – 19.00 WIB (3 August 2022)
3) Friday at 06.00 WIB – 19.00 WIB (Date 5 August 2022)
4) Sunday at 06.00 WIB – 19.00 WIB (7 August 2022)

The time is choosen because on that day and time based on the observations of researchers, it is a day that is usually busy with vehicles passing on the Siliwangi Bekasi highway. Then, the ssecondary data was obtained from internet journals and related government agencies such as Bina Marga, which includes axle load data, damage percentage data and location maps. This data is taken as a reference for researchers during busy hours on Jalan Raya Siliwangi Bekasi.

3.5. Data Analysis Technique

After the observation data has been collected, the amount of traffic and vehicle volume can be calculated. The type of research used in this research is a quantitative type of research. Quantitative research methods are methods that use numbers, starting from data collection to the data analysis stage [5]. Quantitative method is used if the researcher wants to know the effect or certain treatment/treatment between the independent variable and the dependent variable.[6]. According to Williams [7], there are several characteristics of quantitative methods such as:

a. The quantitative approach sees reality as single, concrete, observable, and can be fragmented.
b. The quantitative approach sees the object of research as independent, dualistic and even mechanistic
c. Quantitative approach free from context and time ties (nomothetic statements)
d. The quantitative approach always separates cause and effect and positions the real cause first before finally discussing the consequences

The quantitative approach sees everything value-free, objective and must be as it is. At this stage the data that has been collected will be analyzed with the help of Microsoft Excel and SPSS software. Microsoft Excel is a software program that allows users to process and calculate numeric data (numbers), and SPSS is a statistical data processing software used for interactive, or batch statistical analysis. SPSS stands for Statistical Package for the Social Sciences. The researcher uses Microsoft Excel and SPSS because the data in this study

is numerical data (numbers), and because this study uses statistical analysis. To calculate SMP/Hour are: Number of vehicles X the equivalent value of vehicles.

Table 5. Emp for undivided urban roads.

Road type: Undivided road	Traffic flow total two-way (drive/hour)			Emp	
		LV	*HV*	*MC*	
				WC traffic lane width (m)	
				6	> 6
Two-lane undivided (2/2 USD)	0 1800	1	1.3 1.2	0.5 0.35	0.40 0.25
Four-lane undivided (4/2 USD)	0 1800	1	1.3 1.2	0.40 0.25	

The value of the percentage of damage is obtained from the percentage of the surface area of the damaged road to the total area of the road under review. The formula used to determine the percentage of damage (Np) is as follows: Np = (number of damaged roads / numbers of road sections) x 100%. The value of the percentage of road damage (Np) can be seen in the table below [8].

Table 6. Damage Percentage Value (Np).

Percentage	Category	Score
<5%	So little	2
5-20%	A little	3
20-50%	Currently	5
>50%	Lots	7

Source: Department of Highways

The amount of damage weight value is obtained from the type of damage on the road surface traversed [9]. The assessments include:

Table 7. Damage Weight Value (Nj).

Damage Type	Score
Damage-free concrete construction	2
Damage-free Penetration Construction	3
Patches	4
Cracked	5
Free	5.5
Hole	6
Plot	6
Wave	6.6
Sink	7
Cleavage	7

The value of the amount of damage (Nq) is obtained by multiplying the value of the percentage of damage with the value of the damage weight [9].

$$Nq = Np \; x \; Nj$$

Where:
Np = Percentage of damage
Nj = Damage weight

The value of road damage (Nr) is the total number of damage on one road segment[9].s

$$Nr = \sum Nq$$

Where:
Nq = the value of the amount of damage.

Before starting this research further, below is an overview of the suggested flow for this research to illustrate the process of this research. Road maintenance is road handling which includes maintenance, rehabilitation, support and improvement [10]. The types of road maintenance in terms of the time of implementation are:

1. Routine maintenance is a treatment that is given only to the surface layer which is designed to improve ride quality (Riding Quality), without structural improvement, and is carried out throughout the year.

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2. Periodic maintenance is maintenance carried out on the road at certain times (not continuously throughout the year) and it increases structural strength.
3. Road improvement is the handling of roads in order to improve road services in the form of structural and geometric improvements in order to achieve the planned level of service.

Table 8. Determination of road maintenance handling program.

Road Condition	Damage Limit	Handling Program
Good (B)	<6%	Routine maintenance
Medium (S)	6-11%	Periodic maintenance
Light Damage (RR)	11-15%	Rehabilitation Maintenance
Heavy Damage (RB)	>15%	Structure Improvement Reconstruction

Source:[10]

The determination of the type of maintenance is based on the priority value in Table 9.

Table 9. Determination of Road Maintenance Management Program Based on Priority Value

Road Condition	Damage Limit	Handling Program
0-3	A	Structure upgrade
4-6	B	Periodic maintenance
7	C	Routine maintenance

Source: ref. [10].

4. RESULT AND DISCUSSION

Based on the survey, we can calculate as seen as Table 10.

Table 10. ESALCut Meutia to Narogong.

No.	Type of Vehicle	LHR	AE	ESAL (LHR x AE)
1	5b	417,15	0,3839	160,1439
2	6	491,85	3,0826	1516,177
3	7a	1125,8	4,1970	4724,983
4	7b	1355,9	4,4854	6081,754
5	7c	1051,875	4,9931	5252,117
Total				**17735,18**

Based on the calculation on Table 10, it is known that the Truck Factor value is 4.008 or in other words: Truck Factor (4.008) > 1. This indicates that road damage is caused by traffic load factors.

Table 11. ESAL Narogong to Cut Meutia.

No.	Type of Vehicle	LHR	AE	ESAL (LHR x AE)
1	5b	265,5	0,3839	101,9255
2	6	597,15	3,0826	1840,775
3	7a	1267,5	4,1970	5319,698
4	7b	1023,1	4,4854	4589,013
5	7c	1489,625	4,9931	7437,847
Total				**19289,26**

Based on the above calculation, it is known that the Truck Factor value is 4.403 or in other words: Truck Factor (4.403) > 1. This indicates that road damage is caused by traffic load factors.

Table 12. R square test results Narogong to Cut Meutia direction.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.734[a]	.539	.473	.5731

a. Predictors: (Constant), LG_Volume

With the R Square test, it can be seen that the R Square value is 0.539. Thus it can be said that daily traffic affects road damage by 53.9%.

Table 13. R square test results Cut Meutia to Narogong direction.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.961[a]	.924	.905	.01029

a. Predictors: (Constant), LG_Volume

With the R Square test, it can be seen that the R Square value is 0.924. Thus it can be said that daily traffic affects road damage by 92.4%.

5. CONCLUSION

Based on the calculation of the Truck Factor value on Siliwangi road from Cut Meutia direction to Narogong direction, it is known that the Truck Factor value is 4.008 or in other words: Truck Factor (4.008) > 1. This indicates that road damage is caused by traffic load factors, and based on the calculation of the Truck Factor value on the Siliwangi road from the Narogong direction to the Cut Meutia direction is 4.403 or in other words: Truck Factor (4.403) > 1. This indicates that road damage is caused by traffic load factors. Based on the results of the R Square test on the Siliwangi road from the Narogong direction to the Cut Meutia direction, it is known that the R Square value is 0.539. Thus, it can be said that daily traffic affects road damage by 53.9%. Based on the results of the R Square test on Siliwangi road from Cut Meutia direction to Narogong direction, it is known that the R Square value is 0.924. Thus, it can be said that daily traffic affects road damage by 92.4%.

REFERENCES

[1] S. Sugianto and M. A. Kurniawan, "Tingkat Ketertarikan Masyarakat terhadap Transportasi Online, Angkutan Pribadi dan Angkutan Umum Berdasarkan Persepsi," *J. Teknol. Transp. …*, vol. 1, no. 2, pp. 51–58, 2020, [Online]. Available: https://jurnal.poltradabali.ac.id/jttl/article/view/11

[2] C. Mutiawati and H. Suprayitno, "Tinjauan Awal Struktur Jaringan Jalan di Kota Banda Aceh," *J. Manaj. Aset Infrastruktur Fasilitas*, vol. 2, no. 0, pp. 39–52, 2018, doi: 10.12962/j26151847.v2i0.4823.

[3] M. A. Anas, "Analisis Peningkatan Jalan Pada Ruas Jalan Maliran – Sumber," vol. 1, no. 1, pp. 8–12, 2021.

[4] K. Amri, "Infrastruktur Transportasi dan Kepadatan Penduduk Dampaknya Terhadap Pendapatan Per Kapita: Panel Data Evidence dari Sembilan Provinsi di Sumatera," *J. Ekon. Manaj. dan Bisnis*, vol. 2, no. 2, pp. 438–450, 2014.

[5] I. Jayusman and O. A. K. Shavab, "Aktivitas Belajar Mahasiswa Dengan Menggunakan Media Pembelajaran Learning Management System (Lms) Berbasis Edmodo Dalam Pembelajaran Sejarah," *J. Artefak*, vol. 7, no. 1, p. 13, 2020, doi: 10.25157/ja.v7i1.3180.

[6] Sugiyono, *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta, 2014.

[7] L. S. Musianto, "Perbedaan Pendekatan Kuantitatif Dengan Pendekatan Kualitatif Dalam Metode Penelitian," *J. Manaj. dan Wirausaha*, vol. 4, no. 2, pp. 123–136, 2002, doi: 10.9744/jmk.4.2.pp.123-136.

[8] J. Na'im, Zulkarnaen, and A. Purnama, "Analisis Model Gerakan Aliran Air Terhadap Kerusakan Jalan (studi kasus: Jalan Samota Kabupaten Sumbawa Provinsi NTB)," *SainTekA*, vol. 3, no. 2, pp. 6–11, 2022.

[9] A. Wardani, A. Kristiawan, and N. Samsudin, "Analisis Kerusakan Jalan Akibat Volume Kendaraan 'Studi Kasus : Jalan Raya Semarang Boja Km 38 – 42,'" *J. Tek. Sipil Giratory Upgris*, vol. 1, no. 1, 2020, doi: 10.26877/goratory.v1i1.7907.

[10] A. S. Gemo, "Evaluasi Kerusakan Jalan Dengan Metode Pavement Condition Index (PCI) Pada Ruas Jalan Ki Hajar Dewantara Kota Borong," *J. SONDIR*, vol. 2, no. 1, pp. 1–8, 2019, [Online]. Available: https://ejournal.itn.ac.id/index.php/sondir/article/view/2598

[11] D. W. Saputra, "Pengaruh Arus Lalu Lintas dan Kapasitas Sebelum – Sesudah dilakukannya Pelebaran Ruas Jalan Teuku Umar Kota Bandar Lampung," *Ilmu Tek.*, vol. 2, no. 2, pp. 1–9, 2022.

[12] Priyanto, *Farmakologi Dasar Untuk Mahasiswa Farmasi dan Keperawatan*. Jakarta: Pleskonfi, 2010.

[13] A. Refi, A. Roza, A. P. JF, K. N. Salsabila, and A. M. Rusli, "Analisa Pengaruh Beban Kendaraan Terhadap Kerusakan dan Umur Rencana Jalan (Studi kasus perkerasan lentur jalan ByPass Padang KM 18)," *J. Ilm. Rekayasa Sipil*, vol. 18, no. 1, pp. 27–40, 2021.

[14] S. A. Nanda, T. Ridwan, and D. N. Zidan, "PENGARUH JUMLAH KENDARAAN TERHADAP KERUSAKAN JALAN ASPAL KELAS II (Studi Kasus : Jalan Medan-Banda Aceh Kabupaten Aceh Tamiang)," *J. Teknol. Terap. Sains*, vol. 3, no. 2, 2022.

[15] ALMUFID, Almufid. Perencanaan Geometerik Jalan Agar Mencapai Kenyamanan dan Keamanan Bagi Penggunaan Jalan Sesuai Undang-Undang No. 38 tahun 2012 Tentang Jalan. *Jurnal Dinamika UMT*, 2016, 1.2: 34-45.

[16] MATWEAR, Frisca Natalia; ROKHMAN, Rokhman. PERENCANAAN CAMPURAN MATERIAL SEBAGAI LAPIS PONDASI ATAS JALAN. 2019.