



Analysis of the Influence of Traffic Performance on Air Quality (Case Study: Menteng Raya Bintaro Road Section)

Nadira Novianty¹, Muhammad Isradi^{2*}, Widodo Budi Dermawan³, Andri Irfan Rifai⁴

¹Civil Engineering Student, Faculty of Civil Engineering, Mercu Buana University, Jakarta, Indonesia

^{2,3}Department of Civil Engineering, Faculty of Engineering, Mercu Buana University, Jakarta, Indonesia

⁴Faculty of Engineering & Planning, Universitas Internasional Batam, Indonesia

¹41121110013@student.mercubuana.ac.id, ²isradi@mercubuana.ac.id, ³widodo.budi@mercubuana.ac.id, andri.irfan@uib.ac.id

Abstract

Menteng Raya Bintaro Road Section as one of the main corridors experiences similar problems with increased air pollution and noise due to transportation activities. This study aims to analyze traffic operational performance and examine the relationship between vehicle density and air quality (PM_{2.5}) and noise level on Menteng Raya Bintaro Road Section. The research method uses a traffic performance analysis approach based on the 2023 Indonesian Road Capacity Guidelines (PKJI), with data collection through direct observation for three day) using a time interval of 15 minutes. Measurements include vehicle volume, PM_{2.5} concentration, and noise levels during peak traffic hours. The results of the study show that traffic performance on Menteng Raya Bintaro Road Section is still in normal condition with the highest volume of 3,036 vehicles/hour (Tuesday afternoon 17:15–18:15), degree of saturation (D_s) 0.57 (below the threshold of 0.85), and road capacity of 5,372.97 Vcu/Hour. However, environmental quality showed unhealthy conditions with the highest PM_{2.5} concentration reaching 91.67 µg/m³ (exceeding the 55 µg/m³ quality standard) on Tuesday and the highest noise level of 88.33 dB(A) (exceeding the 55 dB(A) quality standard for residential areas). Correlation analysis revealed a strong positive relationship between traffic density and PM_{2.5} concentrations, particularly on weekdays with values of R² = 0.6143 (Tuesday) and R² = 0.5843 (Thursday), suggesting 58-61% of air quality variations were explained by traffic activity. A similar relationship was identified at the highest correlation noise level on Tuesday (R² = 0.5113).

Keywords: Density, PM_{2.5}, Noise, Traffic.

1. Introduction

The growth of the urban population and the increase in economic activity are driving an increase in the volume of motor vehicles on the highway. Based on data from the Central Statistics Agency (BPS), Indonesia's population is estimated to reach 281.6 million people by mid-2024 [1]. This condition has an impact on declining traffic performance which is characterized by increasing density, decreasing travel speed, and increasing degree of saturation[2].

Traffic jams not only lead to wasted time and fuel, but also contribute to deteriorating air quality as well as increased noise. Facts show that the transportation sector is the main cause of air pollution in urban areas. DKI Jakarta found that the noise level on urban arterial roads was on average above the quality standard threshold of 85 dB(A), especially during morning and evening rush hour [3]. There is a strong linear correlation between traffic density and noise, especially on high-volume arterial roads [4]. According to Government Regulation No. 41 of 1999, air pollution is the entry or inclusion of substances, energy and/or other components into the ambient air by human activities, so that the ambient air quality drops to a certain level that causes the ambient air to not fulfill its function[5]. Referring to Government Regulation Number 41 of 1999 concerning Air Pollution Control, pollutants sourced from motor vehicles consist of carbon monoxide (CO), nitrogen dioxide (NO₂), hydrocarbons (HC), dust particles (PM)₁₀ and PM_{2.5}, and lead (Pb). Several studies confirm that the higher the volume of a motor vehicle, the higher the concentration of CO in the air [6]. Government Regulation Number 22 of 2021 sets a daily limit of PM_{2.5} of 55 µg/m³[7].

A number of previous studies have highlighted the relationship between traffic and air quality and the relationship between traffic and noise. PM concentration display_{2.5} of transportation activities contribute significantly to

respiratory health problems in major Indian cities [8]. In Indonesia, it is reported that the increase in vehicle volume on urban roads is directly proportional to the noise level that exceeds environmental quality standards [9].

Although a number of studies have been conducted, most studies still focus on measuring air quality or noise separately, while the simultaneous relationship between traffic performance, air quality, and noise has not been widely raised in the urban context of Indonesia [10]. Therefore, this study offers a scientific novelty by analyzing the direct relationship between traffic density and PM_{2.5} concentration and noise levels on urban roads with a 4/2 TT configuration [11], [12].

Based on this description, the hypothesis proposed is that the higher the traffic density, this study entitled "Analysis of the Influence of Traffic Performance of Motorized Vehicles on Air Quality (Case Study: Jalan Menteng Raya Bintaro)" will focus on Jalan Menteng Raya Bintaro, which is a 4/2 TT type road with a commercial road classification.

The purpose of this study is to analyze the influence of traffic performance, especially vehicle density, on air quality (PM_{2.5}) and noise level on Menteng Raya Bintaro Road Section, so that it can make a scientific contribution to the development of environmentally friendly transportation studies and become an input for urban transportation policy in Indonesia [13].

2. Research Methods

2.1 Approach, Location, and Time of Research

This study uses a quantitative study design with a field observational approach to analyze the relationship between traffic performance on air quality and noise level [14]. The research activities were focused on collecting primary data directly on Menteng Raya Bintaro Road Section, which was then processed using statistical methods in the form of simple linear regression analysis [15].



Figure 1. Research Location

2.2 Research Samples

In this study, a survey technique was applied to calculate vehicle volume (traffic counting) [16], [17]. The tools that will be used are:

1. Survey forms (JK-I) and (JK-II) for urban roads.
2. Air quality detector and sound level detector



Figure 2. Air Detector and Sound Level Detector

3. Meter
4. Stationery

3. Results and Discussions

Based on a survey that has been carried out on the Menteng Raya Bintaro Road Section, it shows that the highest vehicle volume, air quality, and noise occur during afternoon rush hour. The data is described as follows.

3.1 Geometric Data

The Menteng Raya Bintaro Road Section has a total width of 12 meters with a configuration of 4/2 TT (4 lanes without median). Each lane is 3 meters in size, giving a width of 6 meters in each direction. This paved road is equipped with 1.5 meters wide sidewalks on both sides.



Figure 3. Menteng Raya Bintaro Road Section

3.2 Traffic Volume – Traffic

Traffic volume data on the Jalan Menteng Raya Bintaro section, obtained the highest peak hours on Tuesday, June 17, 2025 at 17:15 - 18:15. The following is a recapitulation of traffic data across peak hours from the three days.

Table 1. Traffic Data Recapitulation – Peak Hours

Monday, 17 June 2025 (17:15 - 18:15)				
Road Sections	MP	KS	BC	Total (Veh/Hour)
Direction B	148	78	1347	1573
Direction T	140	71	1252	1463
Total 2 Ways	288	149	2599	3036
Tuesday, 19 June 2025 (06:00 - 07:00)				
Road Sections	MP	KS	BC	Total (Veh/Hour)
Direction B	81	47	817	945
Direction T	68	45	782	895
Total 2 Ways	288	149	2599	1840
Sunday, 22 June 2025 (06:00 - 07:00)				
Road Sections	MP	KS	BC	Total (Veh/Hour)
Direction B	71	19	585	675
Direction T	54	25	567	646
Sunday, 22 June 2025 (06:00 - 07:00)				
Road Sections	MP	KS	BC	Total (Veh/Hour)
Total 2 Ways	288	149	2599	1321

From the results of the recapitulation in table 4. obtained on Tuesday, June 17, 2025 at 17:15 - 18:15 with a total vehicle volume of 3036 Veh/hour, then the data is calculated using the PKJI 2023 method as follows:

Table 2. Calculation of EMP Peak Values

Kend Type	MP	KB	BC	q ^{TOT}					
EMP Direction 1	0,4	1,3	0,25						
EMP Direction 2	0,4	1,3	0,25						
Directions (1)	Veh/Hour (2)	Vcu/Hour (3)	Veh/Hour (4)	Vcu/Hour (5)	Veh/Hour (6)	Vcu/Hour (7)	Direction % (8)	Veh/Hour (9)	Vcu/Hour (10)
1	148	59,2	78	101,4	1347	336,75	52%	1573	497,35
2	140	56	71	92,3	1252	313	48%	1463	461,3
1+2	288	115,2	149	193,7	2599	649,75	100%	3036	958,65
Directional separation, PA=q1/(q1+q2)								52%	
Vcu/Hour, FVcu=								0,32	

From the results of the calculation in table 2. obtained QTOT based on EMP for both directions of 958.65 vcu/hour.

3.3 Road Segment Capacity

The capacity of the road section stipulates the provisions of the road capacity calculation procedure for the design of traffic performance evaluation. The following are the results of the recapitulation of road capacity presented in table 3.

Table 3. Road Capacity Recapitulation

Parameters Road Section	Value
C ₀	6000 vcu/h
FC _{LJ}	0,91
FC _{PA}	0,994
FC _{HS}	0,99
FC _{UK}	1,00
C	5372,97 vcu/h

3.4 Degree of Saturation

The determination of the degree of saturation refers to the Indonesian Road Capacity Guidelines (PKJI 2023) which is obtained through the division between the value of traffic volume (vcu/Hour) (Q) and the value of road capacity (vcu/Hour) (C).

$$D_j = 0.57$$

3.5 Relationship of Density with PM_{2.5}

Observations of traffic density data and PM_{2.5} concentrations were carried out every 5 minutes and then became an average of 15 minutes. Density is derived from (traffic volume/speed). To clarify the results of the observations, the observation data is displayed as follows.

Table 4. Density Relationship with PM_{2.5} (Tuesday, June 17, 2025)

Time	Density	PM _{2.5} (µg/m ³)
06:00-06:15	12,30	33,33
06:15-06:30	9,80	35,33
06:30-06:45	13,24	38,00
06:45-07:00	15,52	42,67
07:00-07:15	26,28	44,67
07:15-07:30	49,75	43,00
07:30-07:45	38,97	40,67
07:45-08:00	19,83	48,00

Time	Density	PM _{2.5} (µg/m ³)
11:00-11:15	15,40	42,00
11:15-11:30	16,03	45,00
11:30-11:45	26,81	45,33
11:45-12:00	25,02	50,33
12:00-12:15	25,81	56,33
12:15-12:30	26,83	53,33
12:30-12:45	22,77	44,00
12:45-13:00	20,68	57,00
17:00-17:15	33,98	72,00
17:15-17:30	44,15	83,33
17:30-17:45	55,02	89,33
17:45-18:00	80,63	91,67
18:00-18:15	42,39	83,67
18:15-18:30	39,38	72,67
18:30-18:45	25,01	56,00
18:45-19:00	21,83	50,00

The highest PM_{2.5} concentration occurred on Tuesday, June 17, 2025 at 91.67 µg/m³ at 17:45-18:00. Linear regression analysis yields the equation $y = 0.8421x + 30.081$ with $R^2 = 0.6143$. This proves that there is a positive correlation between traffic density and PM_{2.5} concentration, where 61.43% of PM_{2.5} concentration variations are influenced by vehicle density as seen in figure 5 graph.

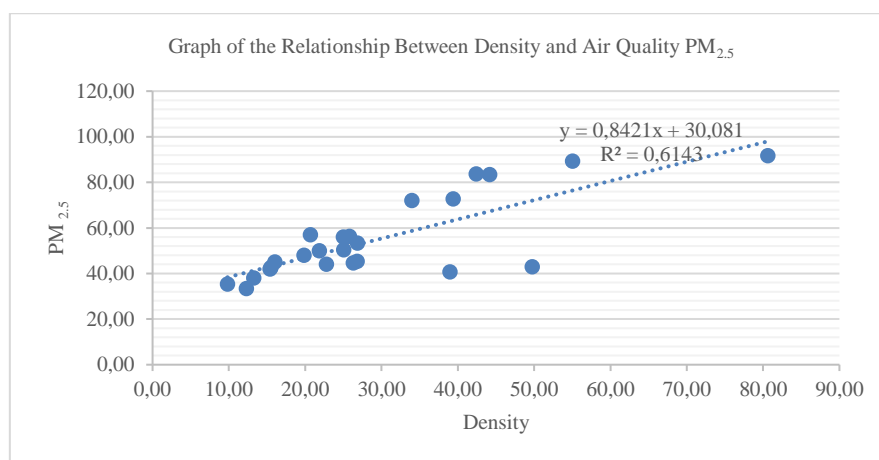


Figure 5. The Relationship Between Density and Air Quality (Tuesday, June 17, 2025)

Table 5. The Relationship of Density to Noise (Tuesday, June 17, 2025)

Time	Density	Noise Level dB (A)
06:00-06:15	12,30	62,33
06:15-06:30	9,80	64,00
06:30-06:45	13,24	68,33
06:45-07:00	15,52	73,00
07:00-07:15	26,28	73,33
07:15-07:30	49,75	73,00

Time	Density	Noise Level dB (A)
07:30-07:45	38,97	71,00
07:45-08:00	19,83	77,33
11:00-11:15	15,40	72,00
11:15-11:30	16,03	73,67
11:30-11:45	26,81	74,33
11:45-12:00	25,02	77,33
12:00-12:15	25,81	76,67
12:15-12:30	26,83	69,67
12:30-12:45	22,77	70,00
12:45-13:00	20,68	68,33
17:00-17:15	33,98	86,33
17:15-17:30	44,15	88,12
17:30-17:45	55,02	88,33
17:45-18:00	80,63	88,33
18:00-18:15	42,39	88,33
18:15-18:30	39,38	87,00
18:30-18:45	25,01	79,00
18:45-19:00	21,83	62,00

The highest noise occurred on Tuesday, June 17, 2025 at 88.33 d(B)A at 18:00-18:15. Linear regression analysis yielded the equation $y = 0.3692x + 64.616$ and $R^2 = 0.5113$. This proves the existence of a positive correlation between traffic density and noise, where 64.61% of noise variations are influenced by vehicle density as seen in figure 6 graph.

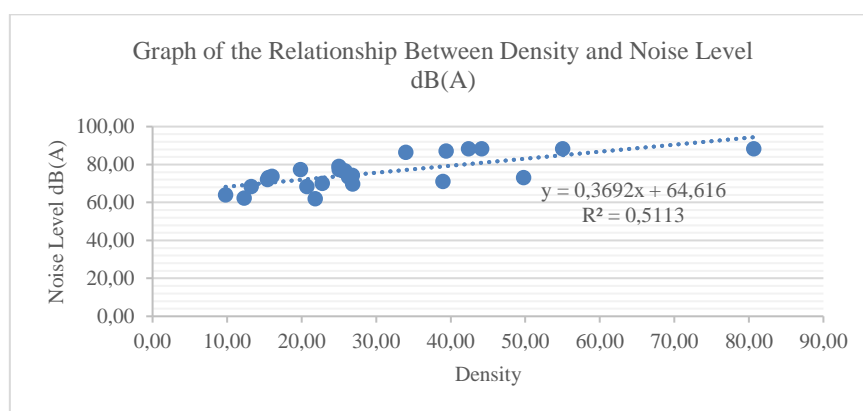


Figure 6. The Relationship Between Density and Noise (Tuesday, June 17, 2025)

Table 6. Density Relationship with PM2.5 (Thursday, June 19, 2025)

Time	Density	PM _{2.5} (µg/m ³)
06:00-06:15	10,49	30,33
06:15-06:30	13,57	33,67
06:30-06:45	15,20	36,33
06:45-07:00	16,23	39,00
07:00-07:15	20,96	49,67
07:15-07:30	18,80	50,33

Time	Density	PM _{2.5} (µg/m ³)
07:30-07:45	32,06	52,33
07:45-08:00	16,99	53,67
11:00-11:15	16,22	42,00
11:15-11:30	15,52	45,00
11:30-11:45	24,26	49,00
11:45-12:00	21,00	50,33
12:00-12:15	19,53	48,00
12:15-12:30	20,72	53,33
12:30-12:45	20,31	52,00
12:45-13:00	16,00	44,33
17:00-17:15	26,47	70,33
17:15-17:30	28,62	68,00
17:30-17:45	29,86	73,00
17:45-18:00	27,15	72,00
18:00-18:15	18,97	64,00
18:15-18:30	15,02	53,33
18:30-18:45	14,57	49,00
18:45-19:00	15,76	50,33

The highest PM_{2.5} concentration occurred on Thursday, June 19, 2025 at 73.00 µg/m³ at 17:30 – 17:45. Linear regression analysis yielded equations $y = 1.5881x + 20.432$ and $R^2 = 0.584$. This proves the existence of a positive correlation between traffic density and PM_{2.5} concentration, where 61.43% of PM_{2.5} concentration variations are influenced by vehicle density as seen in figure 7.

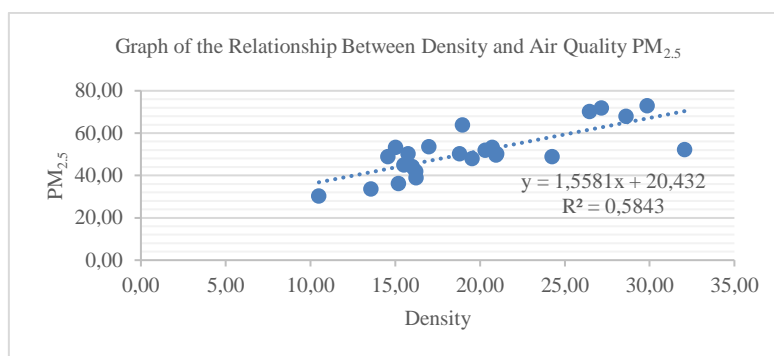


Figure 7. The Relationship Between Density and Air Quality (Thursday, June 19, 2025)

Table 7. The Relationship of Density to Noise (Thursday, June 19, 2025)

Time	Density	Noise Level dB (A)
06:00-06:15	10,49	60,67
06:15-06:30	13,57	64,00
06:30-06:45	15,20	66,67
06:45-07:00	16,23	66,00
07:00-07:15	20,96	76,67
07:15-07:30	18,80	73,33

Time	Density	Noise Level dB (A)
07:30-07:45	32,06	77,00
07:45-08:00	16,99	74,00
11:00-11:15	16,22	72,00
11:15-11:30	15,52	73,67
11:30-11:45	24,26	74,33
11:45-12:00	21,00	77,33
12:00-12:15	19,53	76,67
12:15-12:30	20,72	69,67
12:30-12:45	20,31	70,00
12:45-13:00	16,00	65,33
17:00-17:15	26,47	86,33
17:15-17:30	28,62	87,67
17:30-17:45	29,86	87,33
17:45-18:00	27,15	86,67
18:00-18:15	18,97	86,67
18:15-18:30	15,02	84,67
18:30-18:45	14,57	79,00
18:45-19:00	15,76	75,33

The highest noise occurred on Thursday, June 19, 2025 at 87.67 d(B)A at 17:15 – 17:30. Linear regression analysis yielded equations $y = 0.9115x + 57.446$ and $R^2 = 0.4137$. This proves the existence of a positive correlation between traffic density and noise, where 41.3% of noise variations are influenced by vehicle density as seen in figure 8 graph.

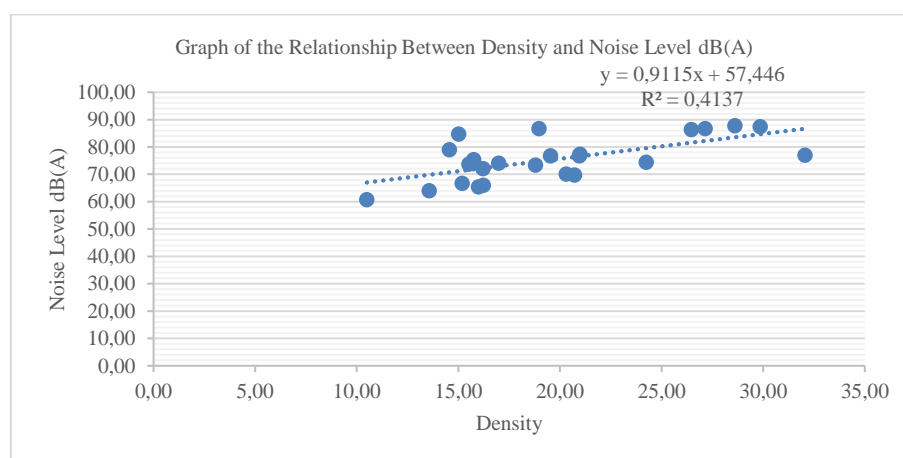


Figure 8. The Relationship Between Density and Noise (Thursday, June 19, 2025)

Table 8. Relationship of Density with PM_{2.5} (Sunday, June 22, 2025)

Time	Density	PM _{2.5} (µg/m ³)
06:00-06:15	10,72	32,67
06:15-06:30	9,19	35,00
06:30-06:45	10,39	36,33
06:45-07:00	11,52	36,67

Time	Density	PM _{2.5} (µg/m ³)
07:00-07:15	14,41	37,67
07:15-07:30	13,03	36,67
07:30-07:45	22,79	41,00
07:45-08:00	11,75	38,00
11:00-11:15	11,07	33,00
11:15-11:30	10,51	32,33
11:30-11:45	16,49	35,00
11:45-12:00	14,31	40,67
12:00-12:15	12,97	39,67
12:15-12:30	15,09	41,67
12:30-12:45	13,62	41,33
12:45-13:00	10,91	38,67
17:00-17:15	18,19	47,33
17:15-17:30	19,59	50,33
17:30-17:45	19,93	50,67
17:45-18:00	18,49	48,33
18:00-18:15	13,09	42,67
18:15-18:30	10,33	37,33
18:30-18:45	10,07	38,00
18:45-19:00	10,73	40,00

The highest PM_{2.5} concentration occurred on Sunday, June 22, 2025 at 50.67 µg/m³ at 17:30 – 17:45. Linear regression analysis yielded equations $y = 1.0303x + 25.492$ and $R^2 = 0.542$. This proves the existence of a positive correlation between traffic density and PM_{2.5} concentration, where 54.2% of the variation in PM_{2.5} concentration is influenced by vehicle density as seen in figure 9.

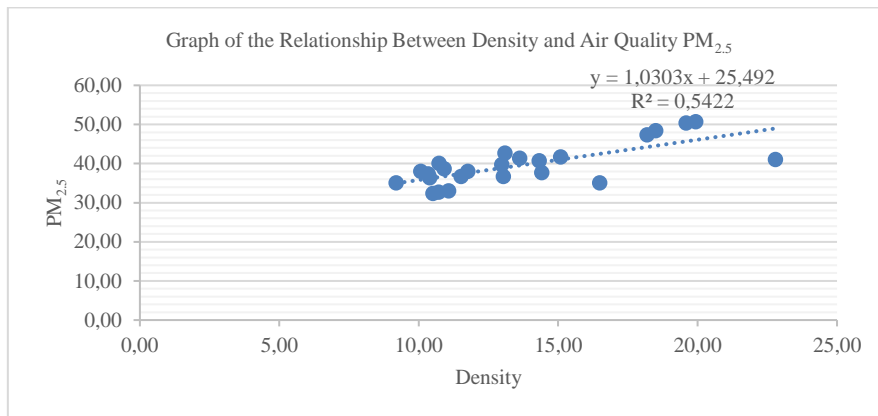


Figure 9. The Relationship Between Density and Air Quality (Sunday, June 22, 2025)

Table 9. The Relationship of Density to Noise (Sunday, June 22, 2025)

Time	Density	Noise Level dB (A)
06:00-06:15	10,72	63,67
06:15-06:30	9,19	62,67
06:30-06:45	10,39	62,33

Time	Density	Noise Level dB (A)
06:45-07:00	11,52	64,33
07:00-07:15	14,41	67,67
07:15-07:30	13,03	66,33
07:30-07:45	22,79	68,33
07:45-08:00	11,75	72,33
11:00-11:15	11,07	72,67
11:15-11:30	10,51	71,33
11:30-11:45	16,49	74,33
11:45-12:00	14,31	77,33
12:00-12:15	12,97	76,67
12:15-12:30	15,09	74,33
12:30-12:45	13,62	65,00
12:45-13:00	10,91	63,67
17:00-17:15	18,19	84,67
17:15-17:30	19,59	85,33
17:30-17:45	19,93	86,33
17:45-18:00	18,49	85,67
18:00-18:15	13,09	84,33
18:15-18:30	10,33	84,00
18:30-18:45	10,07	78,67
18:45-19:00	10,73	74,67

The highest noise occurred on Sunday, June 22, 2025 at 86.33 d(B)A at 17:30 – 17:45. Linear regression analysis yielded equations $y = 1.023x + 59.752$ and $R^2 = 0.212$. This proves the existence of a negative correlation between traffic density and noise, where 21.2% of noise variations are affected by vehicle density as seen in figure 10 graph.

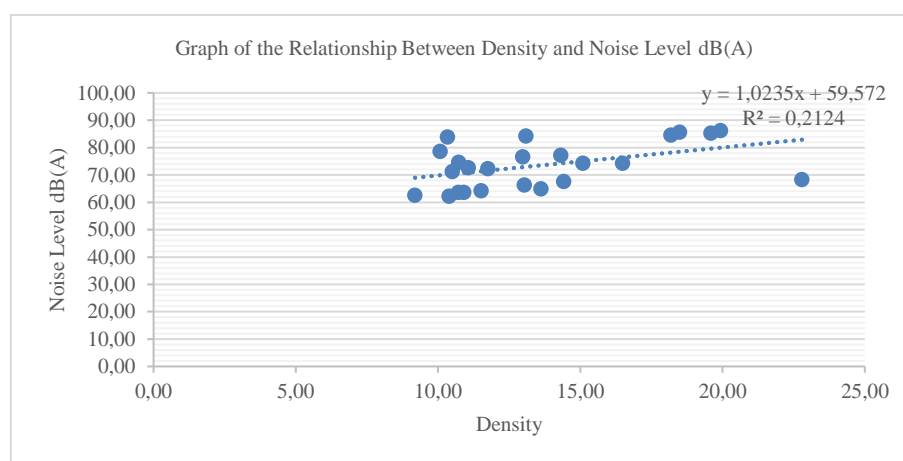


Figure 10. The Relationship Between Density and Noise (Sunday, June 22, 2025)

Based on the results of the discussion, the highest vehicle volume occurred on Tuesday afternoon (17:15–18:15) of 3036 Veh/hour with a capacity value of 5372.97 Vcu/hour on Jalan Menteng Raya Bintaro, and a D_j value of 0.57. The highest $PM_{2.5}$ concentration was recorded on Tuesday, June 17, 2025, which was $91.67 \mu\text{g}/\text{m}^3$ at 17:45 – 18:00. As for the highest noise level, it was recorded on Tuesday, June 17, 2025 at 88.33 dB(A) at 18:00-18:05.

4. Conclusion

Based on the results of the analysis and data processing that has been carried out, several conclusions can be described as follows: 1. Traffic performance on Jalan Menteng Raya Bintaro shows that the highest volume of vehicles occurred on Tuesday afternoon (17:15–18:15) of 3036 vehicles per hour, a degree of saturation value (D_j) of 0.57 which is still below the threshold of 0.85 indicating that traffic conditions are not saturated, with a road capacity of 5372.97 Vcu/Hour, so the operational performance of the road can still accommodate the existing traffic load, 2. The highest $PM_{2.5}$ concentration was recorded on Tuesday, June 17, 2025, which was $91.67 \mu\text{g}/\text{m}^3$ at 17:45 – 18:00. Meanwhile, the highest $PM_{2.5}$ concentration was recorded on Thursday, June 19, 2025, which was $73.00 \mu\text{g}/\text{m}^3$ at 17:30 – 17:45 and the highest $PM_{2.5}$ concentration was recorded on Sunday, June 22, 2025, which was $50.67 \mu\text{g}/\text{m}^3$ at 17:30 – 17:45. According to Government Regulation Number 22 of 2021, the daily limit of $PM_{2.5}$ is $55 \mu\text{g}/\text{m}^3$. Therefore, air quality is classified as unhealthy, especially during peak traffic hours, 3. The highest noise level was recorded on Tuesday, June 17, 2025 at 88.33 dB(A) at 18:00-18:05, for Thursday, June 19, 2025 at 87.67 d(B)A at 17:15 – 17:30, and on Sunday, June 22, 2025 at 86.33 d(B)A at 17:30–17:45. According to the Decree of the Minister of Environment No. 48/MENLH/11/1996 concerning the noise quality standard for residential areas is 55 dB(A) while the noise limit that can be accepted by humans according to Permenaker No. 05 of 2018 is 85 dB(A), 4. There was a strong positive relationship between traffic density and $PM_{2.5}$ concentrations, particularly on Tuesday, June 17, 2025 ($R^2 = 0.6143$) and Thursday, June 19, 2025 ($R^2 = 0.5843$). This means that about 58–61% of air quality variations ($PM_{2.5}$) are explained by traffic density while on Sunday, June 22, 2025 ($R^2 = 0.542$) there is a decrease compared to Tuesday and Thursday, 5. There was a positive relationship between traffic density and noise levels, with the highest correlation value on Tuesday, June 17, 2025 ($R^2 = 0.5113$). This means that about 51% of noise variations are explained by traffic density. On Thursday, June 19, 2025 ($R^2 = 0.4137$) and Sunday, June 22, 2025 ($R^2 = 0.212$).

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