# Analysis of Factors Causing Traffic congestion on Kasokandel Highway, Majalengka

## Moch Yoga Purnama Rifa'i[1], Muhamad Taufik[2], Mulia Pamadi[3]

[1]Civil engineering, Faculty of Engineering, Universitas Majalengka
[2]Directorate General of Highway, Ministry of Public Works, Indonesia
[3]Civil Engineering Program, Universitas Internasional Batam, Indonesia
Correspondence email: yogapurnama769@gmail.com

| ARTICLE INFO | ABSTRACT |
|---|---|
| *Keywords:*<br><br>*Traffic jams*<br>*Traffic*<br>*Highway* | Road traffic congestion on highways has become the most important concern in various countries in the present era. Congestion has become one of the most common problems in densely populated cities due to the rapid growth of transportation use. Road users need traffic signs for information, warnings, and regulations, to reduce road accidents. The purpose of writing this journal is to investigate problems related to traffic congestion to determine urbanization and infrastructure development, this congestion problem is discussed in the journal. The location of this research was carried out on the highway kasokandel, district Kasokandel, district Majalengka, West java. In this qualitative research, we will examine a very complex congestion problem, involving various causal factors and involving many interested parties. Traffic congestion is a major challenge for heavily populated cities, especially in industrialized areas with high population density. Traffic signal systems, signs, traffic regulations are to regulate traffic for safety and efficiency. In the planning of Development of transportation infrastructure and its impact on traffic flow is very important to overcome the problems of traffic congestion, activity Point in time delays, and impacts on the surrounding environment. A highway is a public road built to connect regions, cities, or areas with each other and is used by two- Plus more-wheeled vehicles. Road users need traffic signs for information, warnings, and regulations, to reduce road accidents. Roadways have facilities for pedestrians such as sidewalks, crosswalks, and roadside paths are very important components for pedestrians in the surrounding environment Pedestrian. Therefore, the results of this study are needed to improve infrastructure, road design, and reduce the use of high-emission transportation. |

## 1. Introduction

Traffic congestion on highways is a major concern in many countries today Given the disproportionately high number of small cars in Pakistan compared to the rest of the world, traffic congestion is a significant consequence [1]. In many countries, the increase in the number of two- and more-wheeled vehicles has caused a lot of congestion problems traffic, hinder activities or productivity, and endanger the surrounding environment. Road design, traffic procedures, and the use of emission vehicles are some of the factors that influence traffic congestion, according to research and analysis conducted in various countries the development of an adequate road transportation system is a major need for developing countries [2]. To reduce this problem, Many nations have begun to utilize new approaches, for example smart mobility or green transportation, improved road construction, and reduced use of high-emission vehicles. Traffic congestion is a problem that has a major impact in many countries, this important issue affects the movement and development of a region. Traffic congestion has become one of the common problems in densely populated cities due to the rapid growth of transportation use Traffic congestion has become a ubiquitous issue in crowded cities, primarily driven by the dramatic surge in car ownership [3]. The increasing use of emission vehicles has caused traffic

congestion problems at several points. This greatly impacts the convenience of vehicles and the quality of life for residents in an are the condition of these road sections is critical to ensuring an efficient and safe journey [4]. Transportation systems Substantially affect all economic sectors. The environmental, economic, and social consequences are substantial due to they are directly linked to Human flourishing and economic productivity of cities and towns systems profoundly influence all sectors of the economy, significantly impacting Environmental, socioeconomic, and societal aspects, all of which directly contribute to the quality of life and urban productivity [5]. This problem is influenced by several elements such as road design that does not take into account the comfort of motorists, traffic control procedures that are not considered, an increase in the economy in the area, and the exchange of residents in the area with other areas.

Road congestion is a problem of great concern, especially in Indonesia. Productivity of the community, the surrounding environment, and the welfare of local residents are affected by prolonged traffic congestion Such problems seriously affect the economy when considered as a whole. [6]. oad congestion in certain areas in addition to many transportation users is also caused by indiscriminate parking or illegal parking Parking facilities may utilize road space, however, this is strictly regulated by local government zoning, which designates specific roads for parking [7]. There fore this problem needs to be addressed by the Indonesian government, in order to reduce congestion the Indonesian government needs to improve road infrastructure and transportation systems. For this reason, the transportation system in Indonesia has been assisted using traffic sensors and transportation-based applications, but to solve the problem of traffic congestion, a lot of research and continuous examination must be done.

Vehicle congestion generally occurs during peak hours or working hours that occur every day in the morning and evening, when other people are doing other activities. Congestion in the Jakarta area is one of the impacts of urban development with economic activities that depend on the regions that surround and are interconnected with Jakarta, thus creating the generation of people's movements to the economic center Traffic congestion has become a daily reality in the Greater Jakarta area, frequently discussed by residents. [8]. Traffic congestion requires accurate data to determine the value of traffic performance and capacity of the road section. Road sections and performance are then calculated based on predetermined calculations.

This investigation seeks to deeply analyze the problem of traffic congestion to determine urbanization and infrastructure development, this congestion problem is discussed in the journal. Analyzing this problem aims to determine the impact on society and the development of the region. This research intends to find a solution or suggestion that can be used by the government To advance transportation Improve effectiveness and minimize detrimental consequences associated with traffic congestion. With this, it is expected to understand the problems related to regional mobility. So the title of this journal is "Analysis of Factors Causing Traffic congestion on Kasokandel Highway, Majalengka".

## 2. Literatur Review
### 2.1 Traffic jams

Road traffic congestion Describes the movement and transfer of traffic that is stopped or halted by vehicles - vehicles that are heavily loaded even to the point of exceeding the available road capacity. Traffic congestion refers to the transportation that passes through an area at any given time. Congestion problems often occur due to transportation that increases every year Traffic congestion is a major obstacle to development in many countries, negatively impacting daily life and hindering economic and social progress [9]. However, road infrastructure has not changed, and the more densely populated a city is, the more mobility it will have. This is because the area is the intersection of the residential,

business, and industrial sectors This situation arises from the area's diverse land use, combining residential, commercial, and industrial activities [10].

Congestion is a very complicated problem factor because there are several factors and stakeholders involved in it Traffic congestion is a complex problem because of the many factors and stakeholders involved there [11]. Traffic congestion is a major challenge for heavily populated cities, especially in industrialized areas with high population density. The ever-increasing development of transportation has led to an ever-increasing congestion problem Transportation is widely used almost all over the world [12].

Traffic congestion is a problem that is often found in densely populated cities, especially Majalengka. Majalengka is a small city that has an area of 1,204.24 km² with a growing industrial area. However, Majalengka has approximately 1,340,617 people in 2023. Therefore, the development of transportation in the region is a fairly rapid development that causes a lot of congestion the rapid economic development in Indonesia has caused traffic congestion to increase [13]. Likewise, factory workers and school children are the most concerned due to the rapid development of transportation. With that, motorists must pay attention to driving speed by entering the school zone (Zoss) Effective speed limits are essential for enhancing road safety and minimizing accident risks [14]. Vehicles also emit a lot of exhaust or emissions, especially those that use diesel fuel, the exhaust gas is the same as cigarette smoke which can cause disease The health burden of transportation noise is substantial, mirroring the negative health effects of secondhand smoke [15].

## 2.2 Traffic Flow

Traffic constitutes the continuous Circulation of vehicles and pedestrians Shifting back and forth on a road. Various types of transportation exist involving people and property including pedestrian, public transport, and private transport. In the planning Transportation infrastructure development significantly influences traffic, making it very important to address the problems of traffic congestion, activity time constraints, and impacts on the surrounding environment These areas encompass network infrastructure, transportation, risk mitigation, disaster response, and strategic investment planning [16]. The system of traffic signals, signs, traffic regulations is to regulate traffic to make it safe and efficient. Therefore, traffic signals are needed at every point The success of Intelligent Transportation Systems (ITS) in mitigating congestion and improving public transport relies heavily on the availability of infrastructure that enables smart transport services [17].

The signalized traffic function is a traffic system that uses warning poles or traffic lights as a means of notification or direction on the roadway or a specific area to regulate the movement of transportation and pedestrians Traffic signals guide the movement of all road users, including vehicles and pedestrians, at intersections [18]. The main purpose of traffic signaling is to reduce accidents, improve safety, and efficiency The necessity of installing traffic lights on a large scale in urban areas arises from the inadequacy of other traffic management strategies [19]. Traffic signaling is very important because every highway must have a traffic signal *Traffic Signal Device* is a traffic control device that is commonly [20] The most challenging part of managing an urban area is reducing congestion during working hours, especially congestion in industrial areas One of the most pressing issues for urban areas is effectively managing and reducing traffic congestion [21]. To bring order to traffic and reduce chaos, drivers need to be regulated by traffic signs and navigation systems. In addition, users of safety riding which has been enforced by law for safe driving.

In addition to using the traffic sign system, in Indonesia, drivers are also regulated by the authorities in charge of the traffic unit. The traffic unit authorities can also impose sanctions if they are seen not obeying or obeying the traffic rules and signs that have been posted at several points on the road. Several sections make up The traffic system comprises various elements, each tasked with

controlling flow of traffic And pedestrian movement on the road. The road traffic signs part is to notify motorists in a timely manner visual if there are no traffic signs, traffic jams and accidents will occur [22]. However, transportation now uses an auto pilot system. This can also cause traffic accidents The primary advantage of autonomous driving lies not merely in replacing human drivers with their inherent limitations, but also in the vehicle's ability to predict and communicate with infrastructure and other vehicles [23]. Therefore, motorists must remain careful and pay attention to the traffic signs that have been listed.

## 2.3 Highway

Highways are public roads built to connect regions, cities, or regions to each other and are used by two- and more-wheeled vehicles. Highways have a greater capacity than other roads and are often supported by facilities such as traffic signs, lighting, and stops Roads encompass the entire land-based transportation infrastructure, including all road components, supplementary structures, and equipment, whether at ground level, elevated, underground, or even over water (excluding railways) [24]. Traffic signs are classified into 3: information signs, warning signs, and regulatory signs Trafficroad signages are classified into three categories, namely regulatory, warning and information signs [25] Highways are national roads that have improved infrastructure, such as stronger structures and width, to support high traffic flows of both goods and people. Highway management and planning Needs a universal Comprehending of the layout, Capacity limitations and unique characteristics that influence transportation and pedestrian movements.

Roadways have pedestrian facilities such as sidewalks, crosswalks, and curb ramps that are very important components for pedestrians in the neighborhood The presence of well-designed sidewalks, curb ramps, and crosswalks is essential for the well-being and function of any community [26]. Road users need traffic signs for information, warnings, and regulations, to reduce road accidents While financial motivations may drive improved management, the paramount function of street signage is to enhance road user safety, thus rendering it an essential element [27]. Highway improvements are essential for the development of a region The development of highway infrastructure is essential for fostering socio-economic growth in countries and regions [28].

The road network contains several different routes that have been planned to meet specific mobility and destinations highway network consists of various routes designed for specific mobility purposes. As mobility needs grow, the challenges facing highway transportation will intensify [29]. First, a toll road is a special road built to make traveling faster and easier so as to make the road smoother and unobstructed. Second, major highways are roads that connect one province to another. Arterial roads are built wider to accommodate a higher volume of transportation at a stable speed. Finally, special roads, such as bus roads, motorcycle roads, or sidewalks, are roadways designed to meet specific needs, to prioritize public transport and improve sustainable mobility.

## 3. Method
### 3.1 Qualitative Research

This research uses a qualitative approach, namely by describing and analyzing data in depth Qualitative research encompasses a range of investigative approaches that emphasize naturalistic observation and the analysis of non-numerical data. [30].

### 3.2 Research Site

The research location is focused on the kasokandel highway section, Kasokandel sub-district, Majalengka district, West Java. The length of this research location is $\pm$ 500 meters
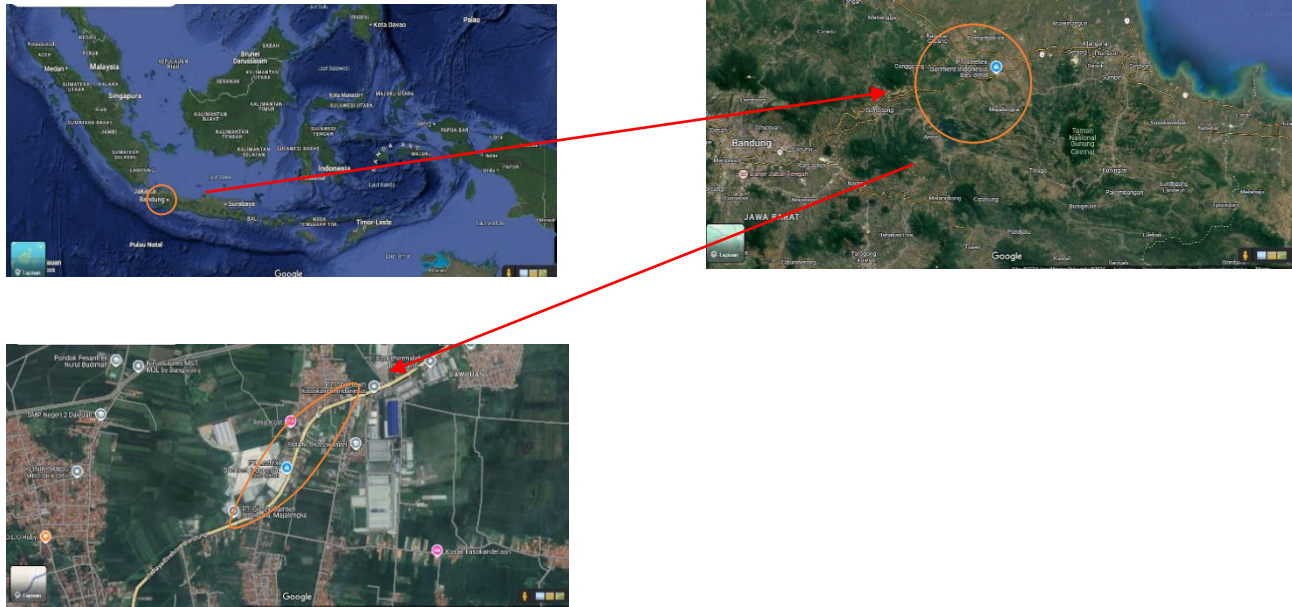


Figure 1. Research Site

### 3.3 Data Collection

Data collection encompasses both primary and secondary sources. Primary data is gathered directly surveys to collect data in the field, in the form of a description of the real situation and conditions that exist at the research location. While secondary data is data obtained to achieve joint goals with other related agencies, for the data obtained, namely: Research Site, and Data on vehicle travel times and prevailing road conditions mapThis research project was carried out conducted on The month of December, beginning on a Monday 2, 2024, Thursday, December 5, 2025, Sunday December 8, 2025. In the morning hours at 07.00 to 09.00 WIB. Then at 10:00 to 11:00. Then in the evening at 18.00 to 19.00. And finally at 21.30 to 22.30.

## 4. Results and Discussion

### 4.1. Road Section Data

The Kasokandel sub-district highway is an arterial road or called an inter-city link, this road is commonly called the Cirebon - Bandung. This road is permitted for freight vehicles and human transportation services between cities. Road data is presented below:

1. Two-lane road with two-way traffic
2. Lane Dimensional breadth of each road section $\pm$3,5 meters
3. Road markings, either in the form of white or yellow lines, serve as a physical barrier between one lane and another

Figure 2. Testing data
Source (Cell phone camera)

## 4.2. Results of Road Traffic Volume Analysis

Road The quantity of the road section that is being used with the capacity of vehicles passing in a certain time. Expressed in vehicles per hour (smp/h). The calculation of road volume is very important to determine the flow of traffic flow in a particular place. Data - data on Traffic volume on the road is very important for planning and managing transportation flows. Road Volume contributes to Ascertain the smoothness Of occurring traffic at that location. The capacity of a road can be analyzed With knowledge of the number of Transportation units passing By means of road.

Tabel 1. Road Density Volume Test Results

| Monday | Number of Vehicles (ken/hr) | | | | | Number of vehicles (Smp/hr) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time | LV | HV | MC | UM | Total | LV | HV | MC | UM | Total |
| 06.00-07.00 | 39 | 63 | 2011 | 4996 | 7109 | 39 | 81,9 | 1005,5 | 4996 | 6112,4 |
| 10.00-11.00 | 31 | 57 | 1987 | 982 | 3057 | 31 | 74,1 | 993,5 | 982 | 2080,6 |
| 18.00-19.00 | 28 | 36 | 2463 | 1103 | 3630 | 28 | 46,8 | 551,5 | 1103 | 1729,3 |
| 21.30-22.30 | 30 | 44 | 987 | 956 | 2017 | 30 | 57,2 | 493,5 | 956 | 1536,7 |
| Thursday | Number of Vehicles (ken/hr) | | | | | Number of vehicles (Smp/hr) | | | | |
| Waktu | LV | HV | MC | UM | Total | LV | HV | MC | UM | Total |
| 06.00-07.00 | 40 | 60 | 1752 | 4705 | 6557 | 40 | 78 | 876 | 4705 | 5699 |
| 10.00-11.00 | 35 | 47 | 1523 | 874 | 2479 | 35 | 61,1 | 761,5 | 874 | 1731,6 |
| 18.00-19.00 | 27 | 33 | 1866 | 1048 | 2974 | 27 | 42,9 | 524 | 1048 | 1641,9 |
| 21.30-22.30 | 36 | 28 | 997 | 865 | 1926 | 36 | 36,4 | 498,5 | 865 | 1435,9 |
| Sunday | Number of Vehicles (ken/hr) | | | | | Number of vehicles (Smp/hr) | | | | |
| Waktu | LV | HV | MC | UM | Total | LV | HV | MC | UM | Total |
| 06.00-07.00 | 47 | 62 | 1578 | 965 | 2652 | 47 | 80,6 | 789 | 965 | 1881,6 |
| 10.00-11.00 | 42 | 54 | 1249 | 671 | 2016 | 42 | 70,2 | 624,5 | 671 | 1407,7 |
| 18.00-19.00 | 51 | 39 | 1199 | 408 | 1697 | 51 | 50,7 | 599,5 | 408 | 1109,2 |
| 21.30-22.30 | 41 | 38 | 871 | 257 | 1207 | 41 | 49,4 | 435,4 | 257 | 782,8 |

The results of the data that has been collected that vehicles passing through reached up to 6112.4 the number of units per hour (smp) occurring between 06 to 07 hours At the time that vehicles pass through the area of the The road segment being analyzed. This Traffic flow is highest due to the conditioning during peak hours or traffic congestion hours.

## 4.3. Hasil Analisa Volume Kecepatan

The speed of vehicle use is very important to determine the speed pattern in traffic flow during different times Analyzing the flow characteristics along the road section of the Kasokandel highway. Patterns The level of speed as information to determine the speed of vehicles during peak hours there is a more efficient buildup of traffic flow vehicles. Vehicle speed can be analyzed by knowing what is used. The results of the traffic speed test are now available the table.

Tabel. 2 Vehicle Results

| Monday | Distance | Total Data | Travel Time | Space Mean Spade | |
|---|---|---|---|---|---|
| Time | Traveled(m) | observation | (Second) | (m/sec) | (km/h) |
| 06.00-07.00 | 500 | 12 | 97.01 | 5.154 | 18.522 |
| 10.00-11.00 | 500 | 12 | 30.15 | 16.583 | 59.698 |
| 18.00-19.00 | 500 | 12 | 54.19 | 9.226 | 33.213 |
| 21.30-22.30 | 500 | 12 | 105.05 | 4.759 | 17.132 |
| Thursday | Distance | Total Data | Travel Time | Space Mean Spade | |
| Time | Traveled(m) | observation | (Second) | (m/sec) | (km/h) |
| 06.00-07.00 | 500 | 12 | 91.10 | 5.488 | 19.756 |
| 10.00-11.00 | 500 | 12 | 37.12 | 13.469 | 48.488 |
| 18.00-19.00 | 500 | 12 | 60.03 | 8.329 | 29.984 |
| 21.30-22.30 | 500 | 12 | 114.30 | 4.374 | 15.476 |
| Sunday | Distance | Total Data | Travel Time | Space Mean Spade | |
| Time | Traveled(m) | observation | (Second) | (m/sec) | (km/h) |
| 06.00-07.00 | 500 | 12 | 57.47 | 8.700 | 31.32 |
| 10.00-11.00 | 500 | 12 | 29.26 | 17.088 | 61.516 |
| 18.00-19.00 | 500 | 12 | 49.35 | 10.131 | 36.471 |
| 21.30-22.30 | 500 | 12 | 60.39 | 8.279 | 29.804 |

The results of the observation data of the highest average vehicle speed reached 61,516 Km / hour on weekends at 10:00 to 11:00 when traffic was moderate Vehicles can move freely according to a fairly high speed. At the same time the lowest vehicle utilization of 15,476 km/h occurs on Thursdays from 9:30 pm to 10:30 pm. During this time the vehicle speed decreases due to heavy vehicle use.

## 4.4. Results of vehicle density analysis

Measures the density of significant vehicular traffic Within the road section over Duration of time. Mean speed (Us) Speed is measured in kilometers per hour, while traffic volume (Q) is quantified in vehicles per hour (Smp/hr), flow speed is similarly quantified in vehicles per hour (smp/hr), Traffic density also needs to be measured using vehicles All data is presented on an hourly basis these measurements are used to conduct traffic density testing. Based on the intensity of traffic flow tested along the lane. This volume data is very important with vehicle counts Along the road, the rate of flow represents the number of vehicles passing a given point within a specific time period that pass through a lane during an hour. To analyze the traffic density on the analyzed road segment, this parameter is also helpful. The results of traffic density testing are in tabel 3.

Tabel 3. Traffic density test results

| No | Monday | Space Mean Speed | Volume (Q) | Rate Of Flow | Density (D) |
|---|---|---|---|---|---|
| | Time | (Us) (Km/h) | (smp/h) | (smp/h) | (smp/h) |
| 1 | 06.00-07.00 | 18.522 | 6112,4 | 24449.6 | 1320.0 |
| 2 | 10.00-11.00 | 59.698 | 2080,6 | 8322.4 | 4 |
| 3 | 18.00-19.00 | 33.213 | 1729,3 | 69.17 | 2.082 |
| 4 | 21.30-22.30 | 17.132 | 1536,7 | 6146.8 | 358.79 |
| No | Thursday | Space Mean Speed | Volume (Q) | Rate Of Flow | Density (D) |
| | Time | (Us) (Km/h) | (smp/h) | (smp/h) | (smp/h) |
| 1 | 06.00-07.00 | 19.756 | 5699 | 22796 | 1153.8 |
| 2 | 10.00-11.00 | 48.488 | 1731,6 | 6926.4 | 142.84 |
| 3 | 18.00-19.00 | 29.984 | 1641,9 | 6567.6 | 219.03 |
| 4 | 21.30-22.30 | 15.476 | 1435,9 | 5743.6 | 371.12 |
| No | Sunday | Space Mean Speed | Volume (Q) | Rate Of Flow | Density (D) |
| | Time | (Us) (Km/h) | (smp/h) | (smp/h) | (smp/h) |
| 1 | 06.00-07.00 | 31.32 | 1881,6 | 7526.4 | 240.30 |
| 2 | 10.00-11.00 | 61.516 | 1407,7 | 5630.8 | 91.53 |
| 3 | 18.00-19.00 | 36.471 | 1109,2 | 4436.8 | 1216.5 |
| 4 | 21.30-22.30 | 29.804 | 782,8 | 3131.2 | 105.05 |

The test results indicate that vehicles passing through reached Maximum occurrence of 1153.8 Smp/hour on Thursday at 06.00 to 07.00, at which time the road was so crowded that vehicles only moved at very Coincidentally, the lowest density was reached at the beginning of the week from 18:00 to 19:00, amounting to 2,082 Smp/hour. Vehicle traffic noticeably thinned out during this time was also seen to decrease.

## 5. Conclusion

Based on the results of testing and discussion that the volume of vehicles reaches its peak from 06.00 to 07.00, namely 6112.7 vehicle units per hour (Smp / hour) which indicates that traffic is in a congested state. As well as the results of the analysis that the speed of vehicles on weekends at 10:00 to 11:00, the average speed of vehicles on that day reached its highest peak of 61.516 Km / hour, the results of this analysis indicate that traffic is observed smoothly. In the results of testing and discussion there is a vehicle speed that reaches the lowest, which reaches 15,746 Km / hour on Thursday at 21:30 to 22:30, this indicates that the vehicle decreases at that time, perhaps due to the use of vehicles that are down. And the density of vehicles on the Kasokandel highway obtained the highest data of 1153.8 Smp / hour on Thursday at 06.00 to 07.00 and the lowest density at the beginning of the week, precisely Monday at 18.00 to 19.00 amounting to 2,082 Smp / hour.

## References

[1] W. Syed, Y. A. H., J. D. and G. Wets, "Analyzing the real time factors: which causing the traffic congestions and proposing the solution for Pakistani City.," *Procedia Computer Science,* p. 1, 2019.

[2] Y. Herdiana, A. I. Rifai, M. Taufik and J. Prasetijo, "The Evaluation of Horizontal Alignment Design: A Case Study of Jalan Tarikolot Majalengka," *Asian Journal of Social and Humanities,* pp. 2814-2825, 2024.

[3] D. Q. Nguyen-Phuoc, W. Young, G. Currie and C. De Gruyter, "Traffic congestion relief associated with public transport:," *state-of-the-art. Public Transport,,* p. 1, 2020.

[4] D. Natalia and A. I. Rifa'i, "Evaluation of Road Damage Using The Pavement Condition Index (PCI) Method on Jalan Raya Waringin, Palasah District, Majalengka Regency," *LEADER: Civil Engineering and Architecture Journal,* pp. 439-448, 2023.

[5] Z. Ali, D. A. A. Shah and A. Hussain, "Growing traffic in Peshawar: An analysis of causes and impacts.," *South Asian Studies,* p. 1, 2020.

[6] G. P. Rocha Filho, R. I. Meneguette, J. R. T. Neto, A. Valejo, L. Weigang, J. Ueyama and L. A. Villas, "Enhancing intelligence in traffic management systems to aid in vehicle traffic congestion problems in smart cities," *Ad Hoc Networks,* pp. 1-2, 2020.

[7] A. J. Rahayu, A. I. Rifai and A. F. Akhir, "The Phenomena of On-Street Parking at Kadipaten Traditional Market, West Java.," *Citizen: Jurnal Ilmiah Multidisiplin Indonesia,* pp. 815-822., 2022.

[8] E. K. Poerwandari, "Chats About Daily Traffic: Agentic Adaptability of Jabodetabek Commuters to Minimize Stress and Transcend Everyday Lives.," *Psychological Research on Urban Society,* p. 2, 2020.

[9] S. J. Kamble and M. R. Kounte, "Machine learning approach on traffic congestion monitoring system in internet of vehicles," *Procedia computer science,* p. 2, 2020.

[10] M. Isradi, H. Dwiatmoko, M. I. Setiawan and D. Supriyatno, "Analysis of Capacity, Speed, and Degree of Saturation of Intersections and Roads.," *Journal of Applied Science, Engineering, Technology, and Education,* p. 2, 2020.

[11] P. A. Kesuma, M. A. Rohman and C. A. Prastyanto, "Risk analysis of traffic congestion due to problem in heavy vehicles: a concept.," *In IOP Conference Series: Materials Science and Engineering,* p. 2, 2019.

[12] T. Resinta and A. I. Rifaâ, "The Traffic Jam Phenomenon at Traditional Village: A Case of User Perception in Batam, Indonesia," *LEADER: Civil Engineering and Architecture Journal,* p. 2, 2023.

[13] P. T. Anugraha, A. I. Rifai, M. Taufik and M. Isradi, "The redesign of provincial road geometric used AutoCAD® 2D: A case Jalan Majalengka-Rajagaluh, Indonesia," *Indonesian Journal of Multidisciplinary Science,* p. 12, 2024.

[14] R. Agustian and M. Pamadi, "SPEED ANALYSIS ON SAFE SCHOOL ZONES (ZOSS): CASE STUDY OF PANYINGKIRAN-MAJALENGKA ROAD," *LEADER: Civil Engineering and Architecture Journal,* pp. 640-647, 2024.

[15] A. Glazener, K. Sanchez, T. Ramani, J. Zietsman, M. J. Nieuwenhuijsen, J. S. Mindell and H. Khreis, "Fourteen pathways between urban transportation and health: A conceptual model and literature review," *Journal of transport & health,* p. 3, 2021.

[16] G. Droj, L. Droj and A. C. Badea, "GIS-based survey over the public transport strategy: An instrument for economic and sustainable urban traffic planning," *ISPRS International Journal of Geo-Information,* p. 3, 2022.

[17] W. H. Lee and C. Y. Chiu, "Design and implementation of a smart traffic signal control system for smart city applications," *Sensors,* p. 3, 2020.

[18] M. Eom and B. I. Kim, "The traffic signal control problem for intersections: a review," *European transport research review,* p. 3, 2020.

[19] S. Akbar and A. J. Saputra, "ANALYSIS OF SIGNALIZED INTERSECTION PERFORMANCE : A CASE SIMPANG EMPAT SMPN 1 MAJALENGKA," *LEADER : Civil Engineering and Artichitecture Journal,* p. 1, 2024.

[20] F. Firmansyah, A. I. Rifai and M. Taufik, "The Performance of Roundabouts with Traffic Signals: A Case Kadipaten Intersection, Indonesia A Case Kadipaten Intersection, Indonesia.," *Citizen: Jurnal Ilmiah Multidisiplin Indonesia,,* pp. 823-832, 2022.

[21] S. S. S. M. Qadri, M. A. Gökçe and E. Öner, "State-of-art review of traffic signal control methods: challenges and opportunities," *European transport research review,* p. 3, 2020.

[22] G. T. N. Fatimah and A. I. Rifa'i, "ANALYSIS OF UNSIGNALIZED INTERSECTIONS: CASE STUDY OF THE INTERSECTION OF JALAN SUKARAJA WETAN, MAJALENGKA," *LEADER: Civil Engineering and Architecture Journal,* pp. 612-620, 2024.

[23] C. Iclodean, N. Cordos and B. O. Varga, "Autonomous shuttle bus for public transportation: A review," *Energies,* p. 3, 2020.

[24] F. A. Muizz, A. I. Rifa'i and A. Fajarika, "ANALYSIS OF THE SUITABILITY OF HORIZONTAL ALIGNMENT TO DRIVER SAFETY LEVEL NEEDS CASE STUDY OF CIGASONG-MAJA ROAD, MAJALENGKA ROAD," *LEADER: Civil Engineering and Architecture Journal,* pp. 818-825., 2024.

[25] M. S. Akple, E. Sogbe and C. Atombo, "Evaluation of road traffic signs, markings and traffic rules compliance among drivers' in Ghana," *Case studies on transport policy,* p. 4, 2020.

[26] F. Cevallos, "Safe and Accessible Pedestrian Facilities Inventory Model (SAPFIM)," *Planning and Design,* p. 4, 2020.

[27] A. Campbell, A. Both and Q. C. Sun, "Detecting and mapping traffic signs from Google Street View images using deep learning and GIS," *Computers, Environment and Urban Systems,* p. 4, 2019.

[28] K. Castañeda, O. Sánchez, R. F. Herrera and G. Mejía, "Highway planning trends: a bibliometric analysis," *Sustainability,* p. 4, 2022.

[29] M. N. F. A. Rachman, "ANALYSIS OF SPEED AND TRAFFIC DENSITY OF JALAN RAJAGALUH-MAJALENGKA. LEADER," *Civil Engineering and Architecture Journal,* p. 4, 2024.

[30] H. Nassaji, "Good qualitative research," *Language Teaching Research,* p. 4, 2020.