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Traffic Congestion Analysis: Case Study of Babakan Road Segment in Majalengka City

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ABSTRACT

Major cities in Indonesia, including Majalengka, are facing significant problems related to traffic congestion. Babakan Road is one of the significant congestion points in the city of Majalengka. Jalan Babakan in the City of Majalengka, during peak hours, one of the busiest roads in Majalengka experiences traffic congestion. This congestion can cause exhaust emissions and queues on the roads. Most roads in the city of Majalengka experience traffic congestion due to the imbalance between population growth, the number of vehicles, and the underdeveloped road infrastructure. This imbalance is caused by the imbalance between population growth, the number of vehicles, and road development. This study aims to determine the impact of traffic congestion on Babakan Road in Majalengka City. This research will use the MKJI 1997 rules as the main reference or foundation to measure and assess congestion needs. In this study, surveys and observations are used to collect data. For primary data, it consists of the number of vehicles passing by, Microsoft Excel 2021, and Traffic Counter software. Secondary data is MKJI 1997. For the data on the highway segment, it consists of a two-lane, two-way road (2/2 UD). This research focuses on studying speed and density to help determine the average vehicle speed and average vehicle density. Regarding the results of the Babakan road study. Low traffic congestion levels usually occur during the day, while high traffic congestion levels usually occur in the morning and evening. Narrow roads, many vehicles, intersections, commuter mobility, and a limited number of public transport are some of the causes of congestion on Jalan Babakan. To address this congestion, there are several alternatives, such as increasing road capacity, increasing the number of public transportation, limiting the number of private vehicles, and setting age restrictions for drivers passing through Jalan Babakan.

1. Introduction

Many cities around the world still see piles of vehicles. Countries with large populations often experience stagnant traffic flows. Traffic congestion, usually caused by population growth and the need to reach activities in different parts of the city, has become a growing problem throughout the world. About 42% of the 245 million people living in Southeast Asia live in urban areas, and this ratio is expected to rise to almost 50% by 2025. To address this problem, some countries have employed solutions such as more efficient mass transportation, vehicle restriction zones, and the use of traffic management technology. At the same time, along with the rapid progress of industry and technology, driving automation, connected autonomous vehicles (CAVs) have become an integral component of the future of transportation trafc fow (Ma, 2025).

Indonesia itself is a country that is ranked in the top 5 as a country inhabited by a very large number of people, 276 million people. This causes Indonesia to not escape the problem of congestion. With the large number of people in an area, the need for transportation will also be higher, causing traffic to

become congested. Congestion in Indonesia is often also caused by vendors selling on the side of the road, so many vehicles slow down or stop on the side of the road. Vehicles that stop on the side of the road will cause accumulation. Traffic volumes continue to increase due to rapid economic growth and urban growth. This often causes problems such as traffic jams. The imbalance of traffic supply and demand on the same spatiotemporal node is the main cause of this problem. (Zhao, 2025).

Traffic jams at several intersections or roads often cause congestion in the city of Majalengka. Congestion occurs when vehicles want to make a U-turn, which usually occurs at road intersections, causing long traffic jams and disturbing drivers. The number of private vehicles and public transportation in Majalengka City continues to increase, causing traffic congestion to become a serious problem. The number of modes of transportation also affects the number of road users which indirectly causes congestion. One of them is the characteristics of road users, as seen in Majalengka City. The root of this problem is multifaceted, stemming from urbanization, increased vehicle ownership, and often inadequate public transportation systems (Taher, 2025).

One of the main roads in the city of Majalengka, Jalan Babakan, is used by many people to go to work and school. Jalan Babakan, Majalengka City, has very heavy traffic in many places, making it one of the most common traffic jams experienced by everyone. This especially applies to students who want to study at SDN 7 Majalengka Wetan. Riders take this route to get to work and to school. Traffic congestion is when more people use the road, characterized by lower speeds, longer travel times, and larger queues. (Goo, 2025).

The analyzed area is the approach used in the study of Jalan Babakan in Majalengka City. Traffic is quite heavy during peak hours, which happens twice a day, once in the morning and once in the afternoon, because many people use this route. On these roads, traffic jams can cause problems for everyone, especially students and employees who are heading to their destination This research aims to find out how road users perceive traffic jams on Jalan Babakan, Majalengka City and how aware they are of traffic jams. Apart from that, the results will be used to determine the impact of traffic jams on Jalan Babakan, Majalengka City.

2. Literature Review

2.1 Transportation

Transportation is something that requires transportation services because everyone has activities. A movement is necessary to perform economic and social operations. Transportation movement is a movement that moves from one place to another. Road geometric design that was the plan of the shape of the road design to maximize the use of the road by users (Herdiana, 2024). To carry out various activities, humans need the availability of transportation facilities. Transportation infrastructure layouts are considered to be closely associated with urban air pollution (Hu X. H., 2025). Ground transportation infrastructure plays a crucial role in community connectivity, economic growth, improving access to education, and supporting sustainable development (Halimi, 2025). While road traffic is infrastructure for the movement of people's vehicles, and or in the form of roads and their supporting facilities (Muizz, 2024).

A good traffic system ensures smooth mobility and regulates the movement of pedestrians and vehicles on roads in a safe, controlled and efficient manner, while minimizing the risk of accidents. Road damage in many countries, including cracks, potholes and surface deformation, affects the safety and effectiveness of transportation. (Kharisma, 2024). However, traffic jams are often a problem in cities

due to less infrastructure and a larger number of vehicles. To address this challenge, various solutions are being implemented, such as the development of better public transportation, the application of smart technology in traffic management, and policies to restrict private vehicles. With continuous improvement, traffic transportation systems can support more convenient and sustainable mobility for people. There is a need for road system development to satisfy current needs of population in cities and outside them, but second goals are to reduce the negative impact of the developing transportation systems (Gontarz, 2025).

An effective and efficient transportation system is not only determined by good traffic engineering but must also be supported by adequate transportation infrastructure. Economic growth will also accelerate if an area has an adequate transportation system supported by reliable facilities and infrastructure. Despite the variety of transportation, Indonesia's transportation system still faces many challenges. He rapid economic development in Indonesia has caused traffic congestion to increase (Anugraha, 2024). Congestion in big cities, uneven infrastructure, and high accident rates are problems that need immediate attention. In addition, integration between transportation modes is still a big challenge for the government and related stakeholders. Disadvantage due to the very little knowledge of planning systems for sustainable transport (Thaba, 2025).

In addition, transportation is essential and serves as the core of economic, social, political life and progress, and population mobility. Advances in transportation go hand in hand with advances in many other fields and subsectors. The movement of people and goods around the world is greatly influenced by the transportation sector (Iyer, 2021). However, transportation is still very important for the economic and socio-economic aspects of the country and society. In addition, urbanization, population density and progress are influenced by transportation and its progress. Residents and employees are attracted to live and work in cities, which is reflected in high urbanization rates. This is due to more job opportunities, higher salaries, and modern amenities and entertainment. Better transport infrastructure reduces the costs of shipping goods and population mobility between regions, encouraging businesses and individuals to change their place of residence, which has an impact on the spatial structuring of economic activities (Pi, 2025).

2.2 Traffic

Traffic is the movement on the highway between vehicles, pedestrians, and goods regulated by a specific system to ensure safe and smooth travel. In big cities, especially during rush hours, there is a lot of traffic, which can cause congestion and slow down the mobility of the community. Traffic conditions are also influenced by factors such as the increase in the number of vehicles, lack of road infrastructure, and undisciplined behavior of road users. To address this issue, effective traffic management, the use of public transportation, and the adoption of smart technologies such as adaptive traffic lights are all necessary measures. Recent advances in automotive technology are about to change the traffic system fundamentally (Ye, 2019). More efficient mobility and a healthier environment will be achieved through the development of a sustainable traffic system. Prediksi arus lalu lintas jaringan jalan yang akurat memungkinkan alokasi sumber daya lalu lintas yang fleksibel dan penyesuaian proaktif rencana pengelolaan. This will be crucial for the future of smart transportation systems and cities (Chen, 2025).

Traffic is a complex phenomenon that involves interactions between various road users, including motor vehicles, pedestrians, and cyclists. Road infrastructure in many countries is developing rapidly in response to increasing demand for more efficient transport and wider access (Nurhasanah, 2024). In the context of ongoing urbanization, traffic has become one of the main challenges in urban planning. Individuals are impacted by traffic congestion as well. Some significant factors brought on by traffic congestion are lost time, particularly during peak hours, emotional stress, and additional pollutants

contributing to global warming (Akhtar, 2021). That the increase in population and vehicles in urban areas contributes to worsening traffic congestion, which negatively impacts mobility, health, and the quality of life of the community. As a result, a better understanding of traffic patterns and dynamics is crucial for formulating effective transportation policies.

The quality of the traffic system can be influenced by a number of factors, both physical and non-physical. Road conditions, road capacity, and the number of vehicles are physical factors, while driver behavior, population density, and government policies are non-physical factors. In addition, environmental factors also affect traffic conditions. found that weather factors, such as rain and fog, can reduce visibility and increase the risk of accidents. The higher the degree of saturation (DS) and delay (DT) shows an increase in intersection performance (Firmansyah, 2022). With the presence of sensor technology and data analysis, real-time information about traffic conditions can be used to optimize vehicle flow and reduce congestion. Traffic congestion is becoming increasingly common in many countries, especially in busier metropolitan cities, where the number of vehicles is increasing, which has negative impact on regional social and economic development (Zadobrischi, 2020).

Traffic accidents are a common problem in urban areas. Highways and intersections that connect main roads to city centers, shopping centers and community empowerment centers often experience traffic jams (Akbar, 2024). Studies show that traffic congestion can cause many losses, including spending more time, consuming more fuel, and emitting more exhaust gases. Many scholars have helped understand the causes of road traffic accidents (Dong, et al., 2025). Some of the main causes of traffic congestion include uncontrolled vehicle growth, inadequate urban planning, and a lack of public transportation infrastructure. Therefore, it is reasonable to assume that traffic volume will rise gradually in a very short time. the government will try unable to effectively manage traffic or establish a safer road transport environment without a thorough grasp of accident severity (Wang, 2019).

2.3 Road Section

A road segment is a specific part of a highway that stretches between two specific locations. This is a term that refers to a section of the road that has multiple lanes and includes components such as intersections and other supporting facilities. Road infrastructure development can in appearance widening the shoulder of the road to minimize congestion (Purnama, 2022). There are various types of roads, such as toll roads, arterial roads, and local roads, depending on their function and environmental characteristics. Roads are an important part of the transportation system that connect various places. Planning and managing roads require a comprehensive understanding of spatial planning, capacity, and characteristics that affect the movement of pedestrians and vehicles. The spatiotemporal regularity of human behaviors, such as the regularity in commuting, makes that some road sections become special and influential in urban road network, which are called critical road sections (CRS) (Gao, 2025).

Road segments are an important component of the transportation system because they connect various locations to each other. Planning and managing road segments require a comprehensive understanding of spatial layout, capacity, and specific features that affect the movement of pedestrians and vehicles. Municipal Roads are local infrastructure and serve as global routes for trade, tourism, and cultural exchange (Dwiani, 2024). A road segment refers to a specific section of a highway that stretches between two specific locations. This is a term that refers to a stretch of road that can consist of one or more lanes and may include components such as intersections, crossings, and other supporting facilities. Highways, main arteries, local roads, and other types are some kinds of road segments, depending on their function and environmental characteristics. Urban areas are very important for the liveliness of

public spaces because they are related to human interaction and pedestrian activity. Cities are also important places to attract talent, capital and business (Doan, 2025).

The highway network has various routes designed to meet specific purposes and mobility needs. First, a toll road is a road designed to make travel fast and efficient with toll facilities that support long-distance journeys. Second, Arterial roads are main roads that connect business and social centers in a city or region. Third, local roads are roads that serve local transportation needs, such as roads in residential neighborhoods or areas. Lastly, special roads, such as bus lanes, bicycle paths, or sidewalks, are highways designed for specific needs, such as prioritizing public transportation or enhancing sustainable mobility. It is very important to understand these types of road segments to build efficient urban planning and transportation systems. The road network considered a very important part of urban structure that serves various urban functional purposes (Hu F. L., 2020).

Each road segment has a specific width designed according to traffic needs, including main lanes, dedicated bike lanes, sidewalks, and road shoulders. Wide roads have a specific purpose to support the sustainability and efficiency of the transportation system. However, while extensive road networks are essential, the main problem remains the construction of safe and effective road geometry (Reta, 2024). In addition, the quality of the road surface greatly affects the comfort and safety of users. Therefore, the maintenance and management of road sections become an important responsibility for the government and related parties to ensure smooth transportation flow and minimize the risk of accidents. Well-connected road segments will enhance accessibility, smoothen mobility, and drive economic growth in the surrounding areas. Easy access with very well developedroad and transportation infrastructure aims to become a tourist destination and revitalize local businesses providing positive effect on quality of life local communities (Kanwal, 2020).

3. Method

The type of analysis used for this congestion analysis is a quantitative analysis. quantitative analysis usually uses analysis and is descriptive in nature. This research will use the MKJI rules as the main reference or foundation to measure and assess the traffic congestion needs on road segments. Such as intersection needs, delay, and degree of saturation can be calculated using this method. Therefore, the level of service provided by that road segment to road users can be identified. In addition, MKJI offers guidelines to identify congestion issues, such as traffic conflicts and the potential for accidents.

The method used is the survey method, the research will be conducted for three days a week, on Monday, Tuesday, and Wednesday. It will be conducted during peak hours, namely from 06:00 to 07:00 in the morning, from 11:00 to 12:00 in the afternoon, and from 16:00 to 17:00 in the evening. The location of this research is in Majalengka, specifically on Jalan Babakan. The traffic problems in Majalengka Regency must be addressed immediately, as Majalengka Regency has well-functioning activity centers. The traffic flow is not smooth in several places, causing poor service at intersections or along road segments. For example, at the Babakan Road location, the road serves as a connecting route between several roads. The absence of traffic signs can cause accidents or hinder the smooth flow of traffic.

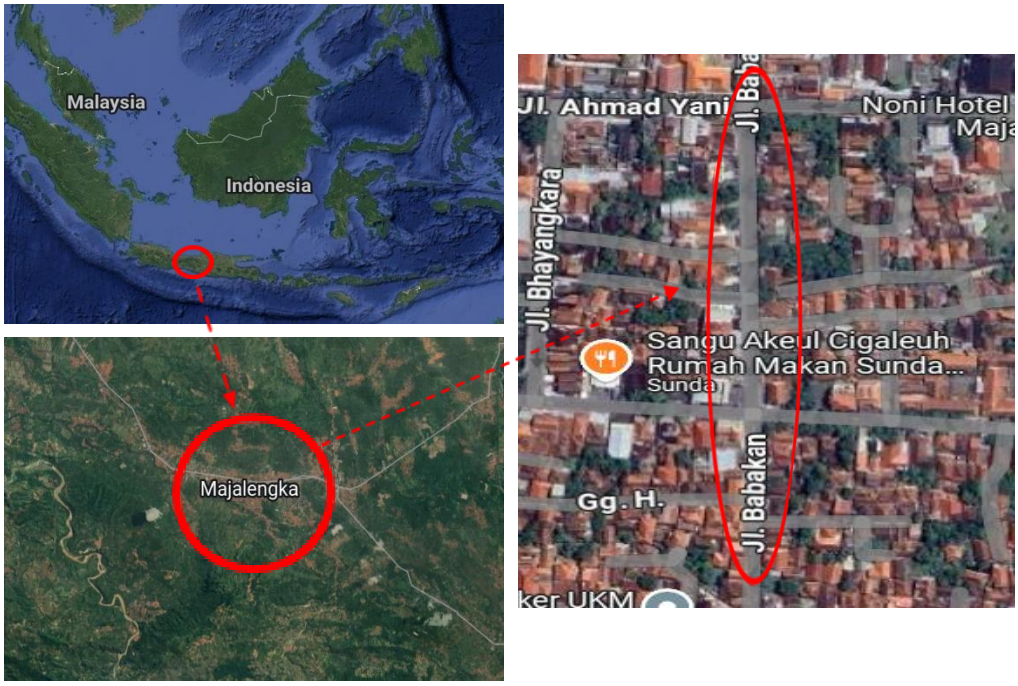

Figure. 1 Research Location

Sumber: Google Maps

4. Results and Discussion

4.1 Road Segment Data

Jalan Babakan is an artery, light goods transport vehicles as well as heavy goods transport vehicles are allowed to pass through this road segment. The road data is as follows:

1. Two-way street with two lanes (2/2).
2. Each lane is approximately ±3,5 meters wide.
3. The lane direction separator consists of a road marking in the form of a dashed line.

Figure. 2 Condition of Babakan Road in Majalengka City

4.2 Road Volume Analysis Results

Vehicle volume is the number of cars that pass through a section of road or part of a road over a certain period, usually measured in units of vehicles per hour (PCU/hour). To understand traffic flow at a specific location, it is very important to measure vehicle volume. For transportation planning and management, data on the number of vehicles is very important. The number of vehicles passing through the road can be used to conduct road capacity analysis because the volume of vehicles determines the traffic load on the road segment being reviewed.

No	Senin	Number of Vehicles (ken/jam)					Number of Vehicles (Smp/jam)				
	Time	LV	HV	MC	UM	Total	LV	HV	MC	UM	Total
1	06.00-07.00	180	43	955	148	1326	180	55,9	477,5	148	861,4
2	11.00-12.00	187	40	730	78	1035	187	52	365	78	682
3	16.00-17.00	158	45	770	135	1108	158	58,5	385	135	736,5
No	Selasa	Number of Vehicles (ken/jam)					Number of Vehicles (Smp/jam)				
	Time	LV	HV	MC	UM	Total	LV	HV	MC	UM	Total
1	06.00-07.00	178	41	905	135	1259	180	53,3	452,5	135	820,8
2	11.00-12.00	185	42	728	62	1017	187	54,6	364	62	667,6
3	16.00-17.00	155	35	764	138	1092	158	45,5	382	138	723,5
No	Rabu	Number of Vehicles (ken/jam)					Number of Vehicles (Smp/jam)				
	Time	LV	HV	MC	UM	Total	LV	HV	MC	UM	Total
1	06.00-07.00	190	50	922	140	1302	190	65	461	140	856
2	11.00-12.00	184	39	715	72	1010	184	50,7	357,5	72	664,2
3	16.00-17.00	160	47	764	129	1100	160	61,1	382	129	732,1

Table.1 Density Volume Test Results

According to the data, the highest traffic level reached 861.4 vehicle units per hour (vph) from 06:00 to 07:00 WIB, when many vehicles passed through the surveyed road segment. This might be due to rush hour or peak traffic hours.

4.3 Road Volume Analysis Results

To understand the traffic flow on the Ligung highway, it is very important to know the vehicle speeds at various times and days. Table 2 shows the results of the traffic speed test, which can be used for transportation planning, traffic management, and more efficient traffic control plans to improve road smoothness and safety.

No	Senin	Number of Vehicles (m)	Number of Observation Data	Travel Time (Second)	Space Mean Spade	
	Time				(m/det)	(km/jam)
1	06.00-07.00	120	12	18,15	6,61	23,79
2	11.00-12.00	120	12	12,20	9,83	35,38
3	16.00-17.00	120	12	15,11	7,94	28,58
No	Selasa	Number of Vehicles (m)	Number of Observation Data	Travel Time (Second)	Space Mean Spade	
	Time				(m/det)	(km/jam)
1	06.00-07.00	120	12	19,06	6,29	22,64
2	11.00-12.00	120	12	12,18	9,85	34,48
3	16.00-17.00	120	12	15,17	7,91	28,47
No	Rabu	Number of Vehicles (m)	Number of Observation Data	Travel Time (Second)	Space Mean Spade	
	Time				(m/det)	(km/jam)
1	06.00-07.00	120	12	21,45	5,59	20,12
2	11.00-12.00	120	12	12,25	9,79	35,24
3	16.00-17.00	120	12	21,49	5,58	20,08

Table.2 Vehicle Speed Test Results

4.4 Vehicle Density Analysis Results

Knowing how many vehicles pass through a segment of road in a certain period is very important. Volume (Q) and flow rate (Q) of vehicles are measured in units per hour (vehicles/hour), and density is measured in units per kilometer per hour. All these parameters are used to perform this traffic density test. Volume (Q) is defined as the number of vehicles that pass a road section in one hour. based on the traffic intensity tested on that section of road. The amount of traffic crossing the road can be calculated using this volume data. The flow rate is the number of vehicles that pass through a lane in one hour. Table 3 shows the results of the traffic density test, which indicates that this parameter enhances our understanding of the traffic levels on the tested road segment.

No	Senin / Time	Space Mean Speed (Us) (Km/Jam)	Volume (Q) (smp/jam)	Rate Of Flow (smp/jam)	Density (D) (smp/jam)
1	06.00-07.00	23,79	861,4	3445,6	144,833
2	11.00-12.00	35,38	682	2728	77,105
3	16.00-17.00	28,58	736,5	2946	103,079
No	Selasa / Time	Space Mean Speed (Us) (Km/Jam)	Volume (Q) (smp/jam)	Rate Of Flow (smp/jam)	Density (D) (smp/jam)
1	06.00-07.00	22,64	820,8	3283,2	145,017
2	11.00-12.00	34,48	667,6	2670,4	77,447
3	16.00-17.00	28,47	723,5	2894	101,650
No	Rabu / Time	Space Mean Speed (Us) (Km/Jam)	Volume (Q) (smp/jam)	Rate Of Flow (smp/jam)	Density (D) (smp/jam)
1	06.00-07.00	20,12	856	3424	170,178
2	11.00-12.00	35,24	664,2	2656,8	75,391
3	16.00-17.00	20,08	732,1	2928,4	145,836

Table.3 Traffic Density Test Results

The test results show that vehicles reached the highest density of 170.178 Smp/hour on Wednesday from 06:00 to 07:00 WIB, when traffic tends to be heavier and vehicles are slower. At the same time, the lowest vehicle density reached 75.391 Smp/hour on Wednesday from 11:00 to 12:00 WIB, and at the same time, vehicle density decreased.

5. Conclusion

According to the analyzed data and tested discussions, between 06:00 and 07:00 WIB, there was an increase in vehicle volume, reaching 861.4 vehicle units per hour, indicating a peak traffic hour. Additionally, the vehicle speed analysis shows that on Monday, traffic was relatively smooth, with the average vehicle speed peaking between 11:00 AM and 12:00 PM WIB, at 35.38 km/h. In addition, the vehicle density on Jalan Babakan reached its highest level of 170.178 Smp/hour on Wednesday from 06:00 to 07:00 WIB, with the lowest level of 75.391 Smp/hour on Wednesday from 11:00 to 12:00 noon WIB.

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