LEADER
Civil Engineering and Architecture Journal

Civil Engineering and Architecture Journal Vol.3 No.3 (2025) 3026-622X
DOI 10.37253/leader.v3i3.10914

Analysis of One-Way Traffic Engineering System on The Majalengka City Health Road Section (In Front of Majalengka Hospital)

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Keywords:
Traffic management,
One Way System,
Road Section, Congestion,

ABSTRACT

This study examines the implementation of a one-way traffic engineering system on the Health Road section of Majalengka City, specifically in front of the Majalengka Regional General Hospital (RSUD Majalengka). The aim of this research is to evaluate the impact of the one-way system on road performance, identify its strengths and weaknesses, and provide recommendations for improvements to optimize road utilization. This study uses traffic volume survey methods, side obstacle analysis, and qualitative assessment. The results show a significant improvement in traffic flow, with the road performance level increasing from "D-E" to "B," although challenges remain in ensuring compliance with traffic regulations. Further recommendations include driver education and the addition of clearer traffic signs to enhance compliance.

1. Introduction

Majalengka, as one of the supporting cities in West Java Province, has immense potential to evolve into a modern center of economic, social, and cultural activities. Strategically located along the main transportation routes connecting major cities in West Java, Majalengka is showing significant signs of transformation. The presence of West Java International Airport (BIJB) Kertajati, situated near the city center, serves as a key catalyst for the region's growth, enhancing connectivity to various national and international destinations. This airport's existence not only impacts the tourism sector but also accelerates the flow of goods and people, driving economic and industrial development.

As this development progresses rapidly, Majalengka's transportation flow has experienced a significant increase. One key road under focus is Jalan Kesehatan, which plays a vital role in connecting the city center with RSUD Majalengka and other areas. This road also functions as a distribution route for goods and facilitates community mobility. Being part of the city's central area, Jalan Kesehatan often encounters traffic congestion, particularly during peak hours, due to the high volume of vehicles (Marzoug, Lakouari, Pérez Cruz, & Vega Gómez, 2022). This issue is exacerbated by external factors such as illegal roadside parking and unorganized pedestrian activities, which further reduce the road's capacity and slow down vehicle flow. Additionally, the frequent halts of commercial vehicles along the road add to the congestion. Addressing traffic issues in an evolving urban area like Majalengka requires innovative and systematic approaches. One widely adopted solution in various countries is the implementation of a one-way traffic system. A one-way traffic system directs vehicles to move in a single direction along a specific road, aiming to reduce traffic conflicts at intersections and increase road capacity.

This system has been proven effective in alleviating congestion, especially in areas with high vehicle volumes. A study by (EG, B, & Purwanto, 2018) revealed that implementing a one-way system can reduce congestion levels by up to 30% on roads with heavy traffic. By channeling vehicles into a single flow, the system minimizes the likelihood of congestion caused by queuing at intersections (Haryati & Najid, 2021). However, while the one-way system offers significant potential to address congestion, its implementation is not without challenges. The success of a one-way system depends heavily on several factors, including road infrastructure readiness and public awareness of traffic regulations. Research by (Pathivada & Perumal, 2019)) on the implementation of the one-way system in Braga, Bandung, showed that although the system initially succeeded in reducing congestion, its effectiveness declined over time. This decline was due to poor traffic sign maintenance, weak enforcement, and non-compliance by some drivers. These findings underscore the importance of comprehensive and sustainable traffic management, encompassing technical planning, public education, and consistent law enforcement.

In the context of Majalengka, implementing a one-way system on Jalan Kesehatan could be a viable step to reduce congestion. However, ensuring its successful execution requires in-depth studies on infrastructure conditions, community needs, and potential impacts on other sectors, such as goods distribution and social mobility. Additionally, leveraging advanced transportation technologies like Intelligent Transportation Systems (ITS) could provide an effective long-term solution for managing traffic. ITS enables real-time traffic management through the use of sensors and predictive software to optimize traffic flow. Implementing ITS in Majalengka could help monitor and control vehicle flow more efficiently while providing real-time traffic information to road users.

A study by Setiawan and (Alsaawy, Alshanqiti, Bhat, & Bahbouh, 2022) on ITS implementation in several major Indonesian cities revealed that this technology could improve traffic efficiency by up to 20%. By integrating this technology into Jalan Kesehatan's traffic system, Majalengka's local government could not only reduce congestion but also improve residents' quality of life through shorter travel times and reduced vehicle emissions. Furthermore, besides technology and traffic systems, sustainability-based approaches to transportation planning are equally important. In many major cities worldwide, policies promoting green spaces, bike lanes, and improved pedestrian infrastructure have proven effective in reducing reliance on private vehicles. By incorporating environmentally friendly transportation concepts, Majalengka would not only benefit from smoother traffic but also create a healthier and more comfortable environment for its residents (Marchant, Hale, & Sadler, 2020).

Thus, this study focuses not only on evaluating the performance of the one-way system on Jalan Kesehatan but also on identifying challenges faced during its implementation. The resulting recommendations are expected to serve as guidelines for local governments and other stakeholders in planning and improving traffic management in Majalengka. The successful implementation of the one-way system and ITS will have a significant impact on the city's mobility, supporting government efforts toward more sustainable and modern development.

2. Literature Review

2.1 The One-Way System

2.1.1 Definition of One-Way System

The one-way traffic system is a traffic arrangement that designates vehicle flow to move in a single direction on specific roads, aiming to reduce complexity and enhance road use efficiency. Implementing a one-way traffic system can reduce traffic congestion by up to 30% on roads with high vehicle volumes. Another advantage of this system is the increased road capacity, as vehicle flow

becomes more orderly and predictable. As a result, this system optimizes the limited road capacity effectively (Sumantri, Rifai, & Ferial, 2022).

2.1.2 Benefits of One-Way System

The one-way traffic system streamlines public mobility and facilitates the distribution of goods, which is essential in densely populated areas and regions with high economic activity. Implementing one-way systems on several main roads increased road capacity by up to 30%. This was achieved through reduced intersection bottlenecks and shorter travel times (Firmansyah, Rifai, & Taufik, 2022). Vehicles moving in one direction eliminate stop-and-go congestion at intersections, making travel time more efficient (Dong, Liu, & Yin, 2022).

Moreover, the one-way system also improves the smooth mobility of people, including the distribution of goods, which is a crucial factor in densely populated areas and regions with high levels of economic activity. A study conducted by Dong, Liu, and Yin (2022) in Jakarta demonstrated that implementing a one-way system on several major roads can increase road capacity by up to 40%. This improvement is attributed to the reduction of obstacles at intersections and decreased travel times. Vehicles moving in a single direction can minimize wasted time caused by stop-and-go conditions or congestion at intersections, making travel times more efficient (Sun, Lin, Jiao, & Lu, 2020)

The one-way system can also contribute to reducing air pollution, as vehicles will stop or idle less frequently at intersections. With smoother traffic flow, fuel consumption can be reduced, which in turn decreases exhaust emissions (Adiputra, Rifai, & Bhakti, 2022).

2.1.3 Challenges in Implementing the One-Way System

Despite its benefits, implementing a one-way system comes with significant challenges (Adiputra, Rifai, & Bhakti, 2022). One major issue is its impact on accessibility, especially in vital areas such as hospitals, markets, and densely populated neighborhoods. Sometimes, a one-way system forces drivers to seek alternative routes to reach their destinations. For example, in residential or commercial areas with narrow streets, changes in traffic flow can negatively affect access to critical locations.

While the one-way system in Braga successfully reduced congestion, its impact on vital areas could not be ignored (Isradi, Mufhidin, Dermawan, Rifai, & Prasetijo, 2022). The effectiveness of one-way systems often diminishes over time due to inadequate maintenance of traffic signs and weak enforcement. Drivers unfamiliar with the new system often violate rules by driving against the flow, leading to traffic accidents and reducing the overall system effectiveness (Sarbaini, 2022).

Another study by (Kharisma, Rifai, Taufik, & Prasetijo, 2024) showed that in several major cities in Indonesia, implementing one-way systems frequently faced issues related to changes in driver behavior. Many drivers do not quickly adapt to the new traffic patterns, leading to violations such as driving against traffic. This presents a significant challenge to the system's success, requiring continuous public education and stricter law enforcement (Kashyap, Devarakonda, Nayak K, KV, & Bhat, 2022).

2.1.4 The Role of Technology in Supporting the One-Way System

To address the challenges of implementing one-way systems, Intelligent Transport Systems (ITS) can offer valuable solutions. ITS enables real-time traffic management using technologies such as sensors, cameras, and predictive software to optimize vehicle flow. ITS also allows traffic authorities to monitor road conditions and provide congestion information to drivers. Research by (Abdurakhmanov, 2022) found that ITS usage improved traffic management efficiency by 25% in densely populated urban areas.

Integrating ITS into one-way systems offers significant advantages by allowing traffic managers to monitor vehicle flow directly and respond quickly to changing road conditions. For

instance, ITS can provide real-time road condition updates to drivers through electronic signboards, helping them choose more efficient and safer routes. Research by Kim et al. ITS implementation in major cities like Singapore and Seoul successfully enhanced traffic efficiency and reduced accidents. In this context, ITS provides a smart solution for maximizing the potential of one-way systems (Zhou, Chen, & Lin, 2022).

2.1.5 The Role of Technology in Supporting the One-Way System

Education and public awareness are key factors in ensuring the successful implementation of one-way systems. Educational campaigns targeting drivers, both experienced and new, can enhance understanding of the new rules and promote adherence to traffic regulations. Research by (Reta, Rifai, Taufik, & Prasetijo, 2024) emphasized the importance of traffic education in improving driver discipline and reducing violations, such as driving against traffic. These campaigns should involve various stakeholders, including the police, transportation departments, and community organizations, to ensure all societal levels understand and support the one-way system (Baffoe-Twum, Asa, & Awuku, 2022).

In some cases, the absence of adequate educational efforts accompanying the implementation of a one-way system can result in high non-compliance rates. Therefore, consistent law enforcement and strict monitoring are necessary to ensure that drivers not only understand the rules but also follow them in practice (Anugraha, Rifai, Taufik, & Isradi, 2024).

2.1.6 Comparative Analysis of the One-Way System

A study by (Ma'aruf, Eprilianto, & Megawati, 2021) in Surabaya demonstrated that implementing a one-way system in densely populated areas increased the average vehicle speed by up to 25%. This system was applied to strategic roads previously prone to congestion due to intersecting traffic flows. Converting these roads to one-way reduced intersection conflicts, enabling smoother traffic flow. However, the success of one-way systems is not solely determined by increased vehicle speed but also by other factors such as road geometry, the number of available lanes, and alternative routes. For instance, in Surabaya, one-way systems proved most effective in areas with relatively wide roads and multiple supporting lanes for traffic diversion. Conversely, in densely populated areas with narrow streets, one-way systems often shifted congestion to alternative routes.

Similarly, in Bandung, the one-way system applied in the Braga area initially reduced traffic density on the main road. However, within months, congestion shifted to other roads used as alternative routes. This indicates that planning for one-way systems must consider overall vehicle flow distribution, not just on the main road but also on surrounding supporting roads (Rahayu, Rifai, & Akhir, 2022). Moreover, user compliance is a crucial factor in the success of one-way systems. In some cities, low public awareness of traffic signs often results in violations such as driving against traffic or illegal parking on one-way streets. Therefore, public education and strict enforcement of traffic regulations are essential to ensure the system's effectiveness (Purnama, Rifai, & Nasrun, 2022).

3. Methodology

This research employs a qualitative approach by collecting primary data through field surveys and secondary data from previous reports. The primary data collected include traffic volume and observations of side obstacles on Jalan Kesehatan. Surveys were conducted over three days during peak hours—morning, midday, and evening—to obtain a more accurate depiction of traffic conditions. The data collected from the surveys were analyzed using the Indonesian Highway Capacity Manual (MKJI) to evaluate road performance and the effectiveness of the one-way traffic system. Additionally,

side obstacle analysis was conducted by mapping the impact of factors such as parked vehicles and pedestrians on traffic flow.

Figure 3.1 Research Location

4.1 Vehicle Volume

The survey indicates that traffic volume on Jalan Kesehatan is quite high during the morning peak hours, reaching 458.3 passenger car units (PCU) per hour. During midday, the traffic volume decreases to 371.15 PCU per hour, and in the evening, it reaches 321.1 PCU per hour. The high volume in the morning highlights significant congestion, which then decreases during midday and evening. These results demonstrate that the one-way system effectively reduces congestion, particularly during the morning rush hours.

Table 4.1 Passenger Car Unit (PCU) Factors

No	Vehicle Type	Emp Factor Value
1	Motorcycle (SPM)	0,25
2	Light Vehicle (KR)	1,0
3	Heavy Vehicle (KB)	1,2

Sumber: MKJI 1997

The table shows traffic volume based on time (morning, midday, evening) with the conversion of vehicles into passenger car units (PCU). The highest traffic occurs in the morning (340.9 PCU/hour), followed by midday (307.45 PCU/hour), and the lowest in the evening (261.2 PCU/hour).

Tabel 4.2 Data Volume Kendaraan

Time	Traffic flow vehicle/hour			Vehicle Volume/hour	Vehicle traffic flow SMP/hour			Vol. smp/hour
	MC	LV	HV		MC * 0.25	LV * 1	HV * 1.2	
Morning	650	176	2	826	162.5	176	2.4	340,9
Afternoon	425	200	1	625	106.25	200	1.2	307.45
Evening	564	120	1	684	141	120	1,2	261.2

4.2 Impact of Lateral Obstructions

The analysis of side obstacles indicates that factors such as parked vehicles and pedestrians affect traffic flow. In the morning, side obstacles are relatively low, but in the evening, side obstacles increase to a moderate level. This suggests that while the one-way system can improve traffic flow, side obstacles remain a challenge that needs to be addressed.

Table 4.3 Impact of Side Obstacles

Side Obstacle Event Type	Symbol	Weight Factor
Pedestrian	PED	0,5
Vehicle Parking	PSV	1,0
Entering and exiting vehicles	EEV	0,7
Slow vehicles	SMV	0,4

Sumber: MKJI 1997

This is the table for the calculation of side obstacles after determining their frequency of occurrence.

Table 4.3 Obstacle Calculation Result

Time	Frequency of Occurrence/200/hour				Frequency of Occurrence/200/hour				Total	Class Side obstacles
	PED	PSV	EEV	SMV	PED*0,5	PSV*1,0	EEV*0,7	SMV*0,4		
Morning	120	20	50	6	60	20	35	2.4	117.4	Low
Afternoon	65	16	20	3	32.5	16	14	1.2	63.7	Low
Evening	46	5	45	1	23	5	31.5	0.4	59.9	Low

4.3 Effectiveness of One-Way System

The implementation of the one-way system successfully improved the road service level from "D-E" to "B," indicating a significant improvement in traffic flow. However, there are still issues with driver compliance with traffic regulations, particularly regarding driving against the flow. Therefore, driver education and improved traffic signage are essential to ensure the effectiveness of the one-way system.

5. Conclusion

This study shows that the one-way system implemented on Jalan Kesehatan in Majalengka has successfully improved traffic flow and reduced congestion, particularly during peak hours. However, side obstacles and driver compliance remain issues that need to be addressed. Recommendations for improvement include increasing driver awareness, improving traffic signs, and better management of side obstacles.

The following conclusions can be drawn from the study on traffic volume:

A. The traffic volume on the road leading to the healthcare area on the morning of December 28, 2024, was recorded as follows: 458.3 PCU/hour between 06:30 – 07:30; 371.15 PCU/hour between 12:00 – 13:00; and 321.1 PCU/hour between 16:00 – 17:00. The traffic volume on Jalan Kesehatan during midday is classified as low.

B. The results of the side friction calculations on Jalan Kesehatan indicate that in the morning, there is a low side friction classification; in the afternoon, there is a normal side friction classification; and in the evening, there is a moderate side friction classification.

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