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Original Article

VISSIM Modeling and Simulation to Optimize the Performance of the Blimbing Ngoro Three-Way Intersection in Jombang Regency

Firda Auliya Ajie Saputri[1*], Andi Patriadi[2], Hanie Teki Tjendani[3]

[1-3]Master of Civil Engineering, Faculty of Engineering, Universitas 17 Agustus 1945 Surabaya, Indonesia
Email: [1)] firdaauliya283@gmail.com, [2)] andipatriadi@untag-sby.ac.id, [3)] hanie@untag-sby.ac.id

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Abstract

This research aims to analyze the existing conditions of the intersection and provide performance improvement solutions through modeling and simulation using PTV VISSIM software. Data was obtained through field surveys, interviews with stakeholders, and related literature studies. The analysis was conducted with reference to the Indonesian Road Capacity Guidelines (PKJI) 2023 to measure performance parameters such as degree of saturation, queue length, and average delay. The results showed that the existing condition of the Blimbing Three Intersection was at the LOS D level of service, with an average delay of 30.99 seconds and a queue length of 26.53 meters, reflecting less than optimal traffic performance. Based on the ARRB analysis, it is necessary to control the intersection by installing traffic signals to improve safety and efficiency. Three proposed scenarios were tested using VISSIM simulation, where Proposal 1 produced the best performance with a delay of 20.34 seconds and a queue of 10.37 meters (LOS C). Proposal 2, with a three-phase arrangement, actually worsened conditions with a delay of 54.72 seconds and a queue of 84.44 meters (LOS D). Meanwhile, Proposal 3, which combines three phases and the left-turn on-ramp feature (LTOR), gives almost as good results as Proposal 1, with a delay of 24.05 seconds and a queue of 16.28 meters, remaining at LOS C. Therefore, Proposal 3 is considered the most effective solution as it is able to improve traffic flow without neglecting the safety aspect.

Keywords: Intersection Optimization, Traffic Performance, Transportation Management, Road Engineering, VISSIM Simulation.

1. Introduction

Jombang Regency is one of the regencies in East Java with an area according to the Jombang Regency Statistics Center of 1,159.50 km² which consists of land and mountainous areas. It has a population density of 1,338,387 people and continues to increase. It is bordered to the north by Lamongan and Bojonegoro regencies, to the south by Kediri and Malang regencies, to the east by Mojokerto regency, and to the west by Nganjuk regency. It has a total of 20 sub-districts and 306 villages (BPS, 2024). The condition of Regency roads in Jombang Regency in 2023 was mostly in good condition, namely 496.41 km out of a total of 665.65 km. When compared to the previous year, the length of the road decreased by 0.30 percent or 1.48 km. This goes hand in hand with the length of roads with moderate and severely damaged conditions which also decreased when compared to the previous year, with a percentage decrease of 35.24 percent and 10.01 percent respectively. Meanwhile, the length of roads with damaged conditions increased when compared to the previous year, with a percentage increase of 53.45 percent (BPS, 2024).

The increase in population and the increasing number of vehicle users have not been matched by an increase in transportation facilities and infrastructure in Jombang Regency. If left unchecked, this will lead to traffic-related problems. One of the problems that arise is intersections, because intersections are network systems where traffic traveling from different directions meets and crosses intersecting vehicle lanes (Balaka & Yudistira, 2018).

Transportation problems in the form of congestion, delays, and noise and air pollution that we often encounter every day in several major cities in Indonesia are already at a very critical stage (Farida et al., 2025). Before the best solution can be determined, the first thing that needs to be done is to study and understand in detail the patterns of interrelationships between the factors that cause these problems in qualitative and quantitative (measurable) form (Tamin, 2000). Transportation planning and modeling is the most effective and efficient medium that can combine all these factors and the output can be used to solve transportation problems both in the present and in the future (Gustavsson, 2008; Minh & Quang, 2021).

Traffic Engineering Management refers to a series of efforts and activities encompassing the planning, procurement, regulation, and maintenance of road equipment facilities aimed at achieving, supporting, and maintaining traffic safety, orderliness, and smooth flow (Zein et al., 2024). Traffic Engineering Management is implemented through the designation of mass transportation by providing dedicated lanes or roads, prioritizing pedestrian safety and comfort, facilitating accessibility for people with disabilities, separating or organizing traffic flow based on land use, mobility, and accessibility, integrating various modes of transportation, controlling traffic at intersections and road segments, and/or protecting the environment (Law of the Republic of Indonesia No. 22 of 2009).

To achieve these objectives, this study will be used to objectively measure traffic performance. The required data will be collected through field surveys, direct observation, interviews with relevant stakeholders, and analysis of documents and secondary data. Field surveys will involve collecting data on traffic volume, vehicle speed, vehicle types, and travel time on Jalan Pahlawan at various times. Interviews with stakeholders such as transportation managers, traffic police, and local residents will provide deeper insights into the problems encountered and proposed solutions.

Traffic congestion is a condition where traffic slows down or comes to a halt due to the number of vehicles exceeding the road capacity (Milanes et al., 2012). One common location for congestion is intersections. Intersections are areas where road segments intersect, causing traffic flow conflicts that often lead to congestion (Hutahaean & Susilo, 2021). Several main factors contribute to congestion, including the increasing number of vehicles not matched by improvements in intersection capacity, which results in traffic volume surpassing the existing capacity and causing increased delays (St Maryam & Said, 2021). Traffic congestion imposes a congestion cost on every road user. Furthermore, vehicle exhaust emissions resulting from congestion contribute to air pollution around the congested areas, which can negatively affect the health of road users (Sassykova et al., 2019). One of the ways to address congestion at intersections is by optimizing the performance of the intersection itself (Wesli et al., 2022).

The rapid economic growth in Gudo District, Jombang Regency, has had a significant impact on transportation activities in the area. As one of the commercial activity centers, the Blimbing three-way intersection serves as a strategic transportation node due to its proximity to the Blimbing Market on the west side and the surrounding commercial shops. The trading activity and the growth of micro, small, and medium enterprises (MSMEs) around the intersection continue to increase, driven by urbanization and regional development. According to Litman (2022), economic growth and intensive commercial activity in a region often lead to increased vehicle volumes, which, if not accompanied by adequate infrastructure, can cause congestion and traffic conflicts. This is highly relevant to the condition of the Blimbing intersection, which has experienced a significant rise in vehicle volume due to population growth and economic activity in the area.

In addition, population growth in this region also contributes to the increasing number of motor vehicles. The population growth is directly proportional to the rising mobility needs of the residents, resulting in increased traffic volume at the Blimbing intersection each year. This condition causes congestion during peak hours, especially when trading activities in the Blimbing Market reach their peak. This aligns with the view of Rodrigue (2020), who stated that "Population growth in an urban area not only drives economic development but also increases the complexity of transportation management, especially at intersections that function as key mobility nodes." However, this intersection faces several urgent problems that need to be addressed. One of the main issues is the absence of Traffic Control at the Intersection, which results in conflicts between vehicle movements. Traffic conflicts often arise between vehicles turning right from the north and vehicles turning left from the west. Based on community reports and police accident data, traffic accidents frequently occur at this intersection due to the lack of traffic control.

According to Tamin (2000), "The performance of an intersection is highly influenced by the existing traffic regulations, and the absence of a control system such as traffic signals (APILL) can increase the potential for vehicle flow conflicts, ultimately leading to accidents." This situation raises concerns among the community and potentially hinders local economic activities. In order to realize good road traffic and transportation management and to support the achievement of performance indicators from the Revised Strategic Plan of the East Java Transportation Agency, particularly in improving intersection and road segment services, it is necessary to conduct a performance analysis of the intersection along with traffic management and engineering efforts on provincial roads in Jombang Regency.

Based on the Decree of the Governor of East Java No. 188/210/KPTS/031/2023 on the Designation of Road Segments as Provincial Roads, there are nine provincial road segments in Jombang Regency with a total length of 62.92 km. The Blimbing three-way intersection is located on road segment (085) Jombang City Border – Blimbing.

The Blimbing Ngoro three-way intersection shows poor traffic performance. Additionally, the land use surrounding the intersection and road segment contributes to the increased volume of vehicles passing through. The land use in this area includes commercial shops, offices, schools, and is near a shopping center. Its location on a provincial road that serves as an inter-regency connector also contributes to the increased congestion in the area. This is an unsignalized four-leg intersection that has not previously undergone any performance analysis or evaluation of road equipment facility needs. Therefore, an analysis is needed to ensure smoother traffic movement at the intersection through simulation and modeling to determine the most appropriate intervention.

This study aims to analyze VISSIM-based modeling and simulation to optimize the performance of the Blimbing Ngoro three-way intersection in Jombang Regency, providing traffic solutions and treatments through simulation and modeling that can be applied to the intersection. In addition, this research may serve as a consideration for policy-making by the Jombang Regency Government and related stakeholders in addressing the prevailing traffic issues.

2. Methods

2.1. Data Collection

2.1.1. Secondary Data Collection

According to Sugiyono (2017), secondary data is data that is already available and collected by other parties, either in the form of official publications, research reports, or administrative documents, which can be used for specific research purposes. The following is the secondary data needed for the study of the Blimbing Three Intersection:

Table 1. Secondary Data

Type of Data	Purpose	Source
Jombang Regency in Figures	To understand geography and climate, governance, socio-demographic development, and the economy	BPS (Statistics Indonesia) of Jombang Regency
Administrative Map of Jombang Regency	To identify the study area	Regional Development Planning Agency (Bappeda) of Jombang Regency
National Road Network in East Java	To identify national road segments in Jombang Regency	BPTD Class II of East Java
Provincial Road Network in East Java	To identify provincial road segments in Jombang Regency	East Java Provincial Transportation Agency
Jombang Regency Road Network	To identify regency road segments in Jombang Regency	Jombang Regency Transportation Agency

2.1.2. Primary Data Collection

In general, primary data is obtained from direct field surveys to collect data on intersections, which includes:

a. Visual Documentation

Photographic documentation of current conditions, obtained directly from the field.

b. Intersection Inventory Survey

This survey involves collecting information on the current physical condition of the intersection, including facilities, infrastructure, geometry, and the surrounding environment to accurately assess the actual conditions on-site. The survey equipment used includes a roll meter, walking measure, clipboard, writing tools, and a mobile phone. The survey implementation involves collecting information on the physical conditions of the intersection, including available facilities, infrastructure, geometric design, and the surrounding environment, in order to determine the actual conditions in the field. The target data required in the inventory survey consists of the length and width of the intersection, other supporting road facilities, land use conditions, as well as the number and types of traffic signs.

c. Classified Turning Movement Counting (CTMC)

The Classified Turning Movement Counting (CTMC) survey utilizes equipment such as a clipboard, writing tools, manual counter, and a survey form. Surveyors are positioned at designated observation points on each leg of the intersection, ensuring they have a clear view of the traffic flow. Vehicle movements are recorded at 15-minute intervals during peak hours in the morning, noon, and afternoon. At least three surveyors are required, with each responsible for documenting vehicles turning right, turning left, and going straight. The target data includes the number and percentage of vehicles making each type of turning movement at the intersection, as well as any traffic conflicts that occur during the observation period.

The following is the primary data required for the study of the Blimbing Three-way Intersection Performance Analysis:

Table 2. Primary Data

Type of Data	Purpose	Source
Traffic Volume	To calculate the intersection saturation level and level of service.	Classified Turning Movement Counting Survey
Road Geometry	To determine the road's capacity and characteristics in accommodating traffic.	Inventory Survey
Road Equipment Facilities	To assess the condition and needs of road equipment around the intersection.	Intersection Inventory Survey

2.2. Data Analysis Technique

2.2.1. Intersection Performance Analysis with PKJI 2023

Capacity calculation is distinguished for two main purposes: first, for the operational analysis of an intersection, and second, for intersection design analysis. The primary objective of the operational analysis of an intersection based on existing or projected conditions of geometry, traffic, and the surrounding environment is to assess the Capacity (C), Degree of Saturation (Dj), Delay (T), and Queue Probability (Pa) expected to occur on the road.

The main objective of designing a new intersection or upgrading an existing one is to determine the optimal intersection type based on the Peak Hour Traffic Volume (LHRT) or Critical Movement Flow (qJP) for each movement from both major and minor roads, in accordance with specific design criteria. The entire procedure consists of three main steps:

a. Step A: Define input data
b. Step B: Determine intersection capacity
c. Step C: Evaluate traffic performance

For evaluating the operational condition of an intersection, the primary input data in Step A includes existing geometric data and traffic flow data for each movement from both major and minor roads. The next step is to calculate the intersection's capacity and performance using Step B and Step C, followed by describing the outcomes in terms of C, Dj, T, and Pa.

2.2.2. Analysis Using PTV VISSIM

PTV VISSIM (Verkehr in Staedten SIMulasion) is a microscopic traffic simulation software used to model urban traffic and public transport operations. The program allows for detailed traffic and mobility analysis with modeling parameters such as lane geometry, vehicle composition, traffic signals, stop lines, driver behavior, and more. Therefore, this software serves as a valuable tool in evaluating various transportation engineering alternatives to support effective and efficient decision-making in planning activities, including model development simulations (User Manual PTV VISSIM 10.0, 2017).

2.2.3. Simulation Model Calibration and Validation

Simulation model calibration is the process of adjusting simulation parameters so that the simulated data closely matches the observed field data. The simulation parameters adjusted include urban motorized driving behavior parameters, covering car following, lane change, lateral movement, and input parameters such as connectors, desired speed distributions, reduced speed areas, and driver behavior related to priority rules.

Traffic flow data used for comparison in the calibration process includes the inbound and outbound traffic volumes at the intersection or roundabout approach within the road network. This traffic data, directly linked to the simulation model, serves as input for validation. To ensure that the simulation model meets calibration requirements, statistical testing is conducted using the Geoffrey E. Havers (GEH) statistic (Gustavsson, 2008), defined as:

$$GEH = \sqrt{\frac{(\text{q simulated} - \text{q observed})^2}{0{,}5 \text{ x } (\text{q simulated} - \text{q observed})}}$$

where:
q simulated : traffic volume from simulation results (vehicles/hour)
q observed : traffic volume from field observations (vehicles/hour)

The interpretation of GEH values for assessing data comparison validity can be found in Table 3.

Table 3. GEH Terms

GEH Value	Statement
GEH < 5,0	Accepted (no significant difference)
5,0 ≤ GEH ≤ 10,0	Model error or poor data
GEH > 10,0	Rejected (significant discrepancy detected)

Source: Gustavsson, 2008

To compare the amount of traffic flow on the approach to the intersection or roundabout between the simulation model results and field observations, the simulation model of Blimbing three-way intersection under existing conditions was run for a period of 1.0 hour three times. To accommodate the effect of stochastic traffic, simulation runs were conducted four times with different random seeds. The simulation model results from the four simulation runs were then averaged to compare with the field observations.

3. Results and Discussion

3.1. Problem Identification

a. The Blimbing three-way intersection is currently not equipped with traffic control measures. This condition has the potential to create traffic conflicts that may lead to accidents and endanger road users' safety, especially as traffic density continues to increase.

b. The absence of protected vehicle movements on the west and east legs of the Blimbing three-way intersection creates a high risk of accidents. On the east leg, the majority of vehicles turn right (north), while the west leg is dominated by motorcycles attempting to cross to the east side and are forced to wait for vehicles from the east leg to pass before being able to cross.

c. There is a significant delay at the intersection during busy periods, with an average delay of approximately 30.99 seconds. Therefore, optimization of the intersection's performance is necessary.

3.2. Determination of Intersection Control Type

The current condition of the Blimbing Three Intersection is an unsignalized intersection, but as traffic growth develops, it is necessary to review the type of control at this intersection.

Intersection control is determined using the intersection control criteria graph shown in Figure 1, which is based on the traffic volume of each leg of the intersection. The calculation is conducted per unit of time, for example, during peak traffic hours in the morning, afternoon, or evening.

The Design Hour Volume (DHV) is obtained from the classified vehicle volume during peak hours, which is then divided by the K factor. The K factor is a value derived from the type of city and the road environment. Thus, the calculation for the Blimbing three-way intersection is as follows:

3.2.1. For Major Road Traffic Flow

Design Hour Volume (DHV) = 1,467 PCU/hour

The K factor, considering that the population of Jombang Regency exceeds 1 million people and the intersection is located in a commercial area, is 8%. Therefore:

$$LHR = \frac{\text{Design Hour Volume}}{\text{K Factor}}$$

$$= \frac{1467}{0{,}08}$$

= 18.333 vehicles/day

3.2.2. For Minor Road Traffic Flow

Design Hour Volume (DHV) = 782 PCU/hour

Using the same K factor of 8% due to the same population and area classification:

$$LHR = \frac{\text{Design Hour Volume}}{\text{K Factor}}$$

$$= \frac{782}{0{,}08}$$

= 9.775 vehicles/day

Based on the calculation results of the traffic volume passing through the Blimbing three-way intersection and the comparison with the intersection control type graph, the results indicate that the Blimbing three-way intersection requires a roundabout or signalized intersection (APILL) as the appropriate type of control.

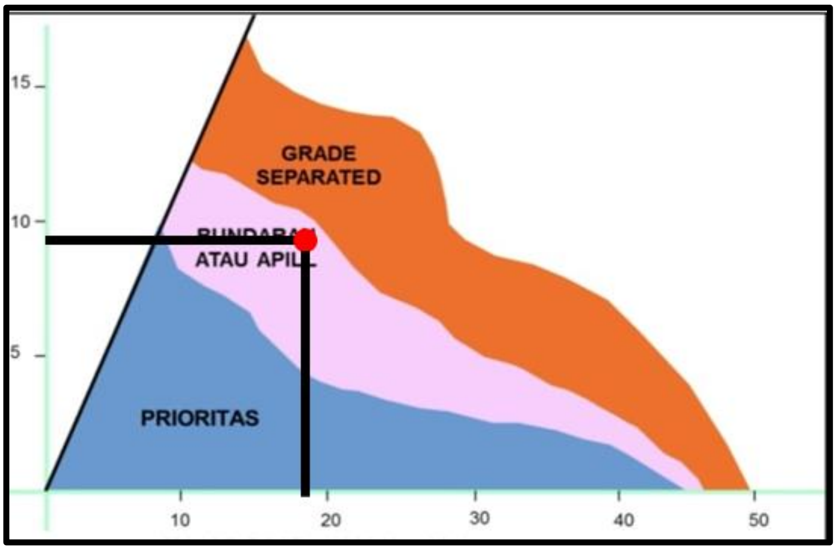

Figure 1. Traffic Control Graph for Blimbing Three-Way Intersection

3.3. Traffic Handling Recommendations

3.3.1. Proposal 1 (Installation of 2-Phase Traffic Signal)

To improve the intersection's performance and enhance road user safety and comfort, traffic management and engineering are required. Based on the determination of the intersection control type, the Blimbing Three-Way Intersection requires a traffic control system with a Traffic Signal (APILL).

The installation of Traffic Signal Devices (APILL) with a two-phase control system aims to improve traffic safety at the intersection. This setup is designed to minimize vehicle conflicts. Although this configuration does not entirely eliminate potential conflicts on the east and west sides, it is expected that the queues and delays at the Blimbing Three-Way Intersection will remain manageable.

To optimize the performance of the intersection, a two-phase traffic control system with a total cycle time of 42 seconds is proposed. This approach aims to accelerate vehicle flow and minimize waiting times for vehicles in each direction. Below is the proposed cycle time table for Proposal 1:

Table 4. Proposed Cycle Time Setup for Proposal 1

No	Approach	Time			
		Cycle	Green (Seconds)	Yellow (Seconds)	Red (Seconds)
1	North	42	14	3	21
2	East & West		16	3	23

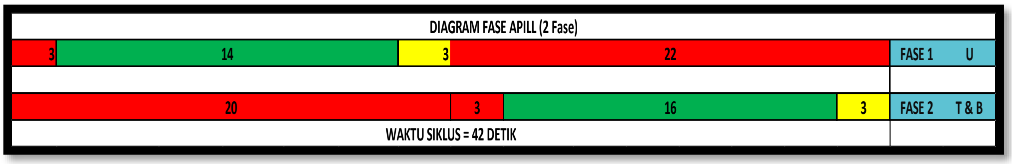

Figure 2. APILL Phase Diagram for Proposal 1

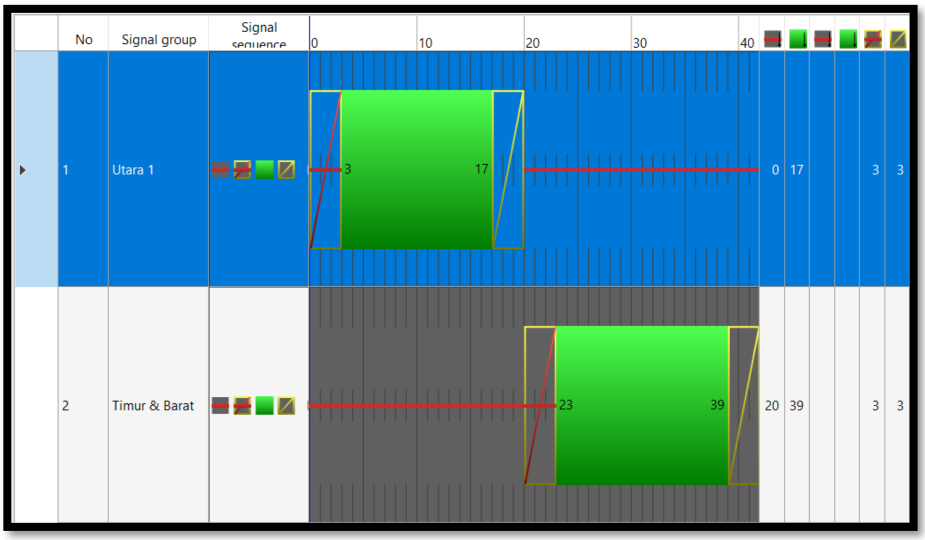

Figure 3. Modeling of Phase Configuration for Proposal 1

The results of the first proposal show the use of an APILL (Traffic Signal Device) with a two-phase system and a total cycle time of 42 seconds. For the North approach, the green light lasts for 14 seconds, followed by a yellow light for 3 seconds, and a red light for 21 seconds.

Meanwhile, the East and West approaches each get a green light for 16 seconds, a yellow light for 3 seconds, and a red light for 23 seconds. Additionally, there is an all-red (all red lights) time gap of 3 seconds and an amber (yellow) light for 3 seconds. The traffic performance based on this setup is shown in Table 5.

Table 5. Traffic Performance Parameters for Proposal 1

No	Name	Traffic Performance Parameters		
		Average Vehicle Delay (seconds)	Queue Length (meters)	Level of Service
1	Proposal 1 (2 Phase)	20,34	10,37	LOS_C

Table 5 shows the traffic performance analysis results for Proposal 1, which involves a two-phase traffic control setup. In this simulation, the average vehicle delay is recorded at 20.34 seconds, which represents the average time required for a vehicle to continue its journey after stopping. Additionally, the queue length formed by vehicles is around 10.37 meters, indicating the length of the queue that vehicles must wait in before proceeding. Based on this data, the Level of Service (LOS) for this traffic control proposal is LOS C, indicating that traffic conditions are still stable, though vehicles experience slight delays and disturbances in their journey.

3.3.2. Proposal 2 (Installation of a 3-Phase APILL)

The second proposal focuses on enhancing the safety and comfort of road users at the intersection. In this proposal, the traffic signal system is designed using a three-phase system. The aim is to minimize conflicts between vehicles that may occur due to interactions from various directions.

With the three-phase setup, each phase is designed so that the traffic flow from each direction has a clear and separate turn, reducing the potential for vehicle collisions. This system also provides adequate time for both vehicles and pedestrians to move safely and comfortably. To enhance safety at the intersection, a traffic signal setup with three phases is proposed, with a total cycle time of 89 seconds. This approach aims to improve safety and reduce traffic conflicts. The cycle time configuration for Proposal 2 is shown in the following table:

Table 6. Cycle Time Configuration for Proposal 2

No	Approach	Time			
		Cycle	Green (Seconds)	Yellow (Seconds)	Red (Seconds)
1	North		20	3	66
2	East	89	24	3	62
3	West		27	3	59

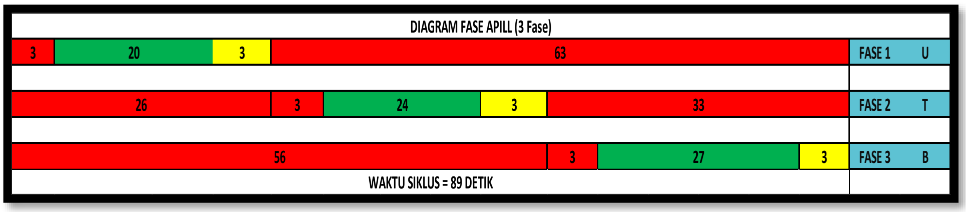

Figure 4. APILL Phase Diagram for Proposal 2

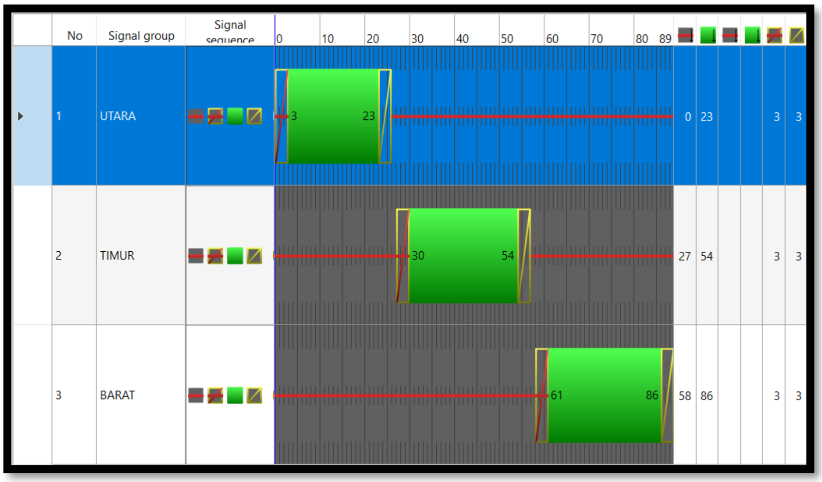

Figure 5. Modeling of Phase Configuration for Proposal 2

The results of this proposal show the use of traffic signal control (APILL) with a 3-phase system and a total cycle time of 89 seconds. For the North approach, the green light is on for 20 seconds, followed by the yellow light for 3 seconds, and the red light for 66 seconds. The East approach gets the green light for 24 seconds, yellow for 3 seconds, and red for 62 seconds. For the West approach, the green light is on for 27 seconds, yellow for 3 seconds, and red for 59 seconds. In addition, there is a 3-second all-red (all red lights) interval and a 3-second amber (yellow) interval. Traffic performance based on this arrangement is shown in Table 7.

Table 7. Traffic Performance Parameters for Proposal 2

No	Name	Traffic Performance Parameters		
		Average Vehicle Delay (seconds)	Queue Length (meters)	Level of Service
1	Proposal 2 (3 Phase)	54,72	84,44	LOS_D

Table 7 shows the traffic performance analysis results for Proposal 2 with a three-phase arrangement. In this proposal, the average vehicle delay is 54.72 seconds, indicating a relatively high delay time for vehicles to pass a certain point. The average queue length of vehicles reaches 84.44 meters, meaning that there is a considerable vehicle queue before they can proceed. The Level of Service (LOS) for this scenario is LOS D, indicating that traffic conditions are approaching the capacity limit, with significant delays and disruptions for road users. This proposal provides a more burdened traffic performance compared to the previous condition but increases safety by directly reducing traffic conflicts.

3.4. Proposal 3 (Installation of APILL 3-Phase with Direct Left Turn)

The third proposal focuses on improving traffic performance at the intersection with the 3-phase APILL system through the implementation of the "direct left turn" concept. This approach allows vehicles from a specific direction to continue moving without waiting for the green light, thereby reducing queues and accelerating the overall flow of traffic.

The implementation of direct left turns is designed with user safety in mind. Traffic signs and road markings will be adjusted to ensure that drivers understand the rules, and pedestrians remain protected. This is done to ensure that not only traffic flow is improved, but also the safety of all road users is maintained.

With this concept, it is expected that potential delays on certain lanes can be minimized, so the overall performance of the intersection can improve without compromising the safety and comfort of road users. To further improve traffic performance at the intersection from the previous proposal, it is suggested to implement a three-phase traffic light system combined with direct left turns, maintaining the total cycle time of 89 seconds. This approach aims to enhance safety and reduce traffic conflicts. Below is the table for the cycle time arrangement in Proposal 3:

Table 8. Cycle Time Configuration for Proposal 3

No	Approach	Time			
		Cycle	Green (Seconds)	Yellow (Seconds)	Red (Seconds)
1	North	89	20	3	69
2	East		24	3	62
3	West		27	3	59

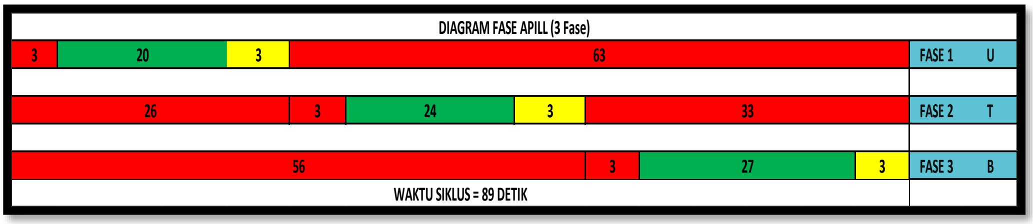

Figure 6. APILL Phase Diagram for Proposal 3

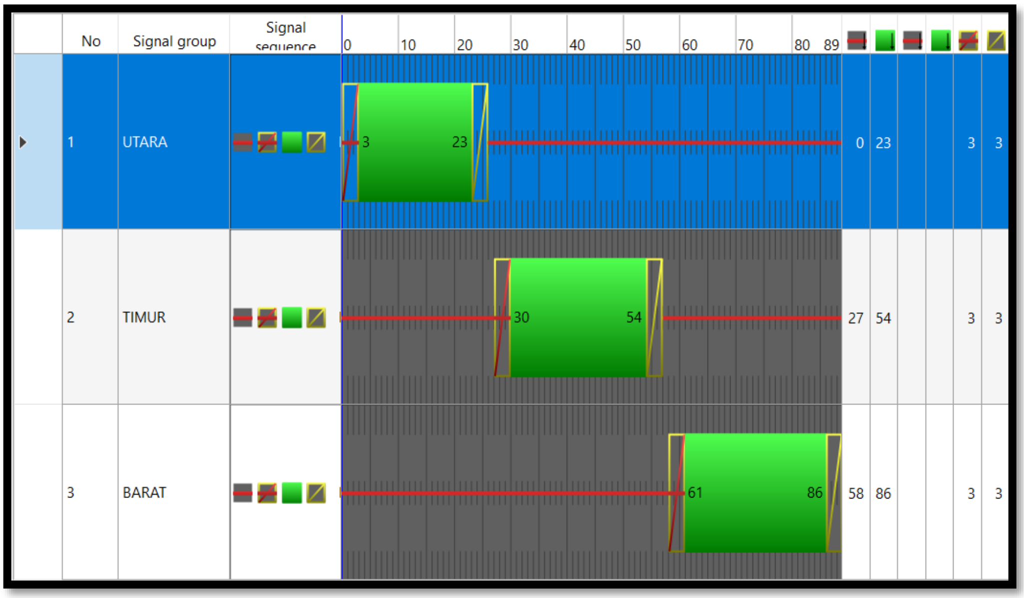

Figure 7. Modeling of Phase Configuration for Proposal 3

The results of this proposal show the use of the 3-phase traffic signal system (APILL) with a total cycle time of 89 seconds, which is the same as the previous proposal. For the North approach, the green light stays on for 20 seconds, followed by 3 seconds of yellow and 66 seconds of red. The East approach receives the green light for 24 seconds, yellow for 3 seconds, and red for 62 seconds. For the West approach, the green light is on for 27 seconds, yellow for 3 seconds, and red for 59 seconds. In addition, there is a 3-second all-red (all red lights) interval and a 3-second amber (yellow) interval. Traffic performance based on this arrangement is shown in Table 9.

Table 9. Traffic Performance Parameters for Proposal 3

No	Name	Traffic Performance Parameters		
		Average Vehicle Delay (seconds)	Queue Length (meters)	Level of Service
1	Proposal 3 (3 Phase + LTOR)	24,05	16,28	LOS_C

Table 9 shows the results of the traffic performance analysis for Proposal 3 (3 Phases + LTOR). In this proposal, the average vehicle delay is 24.05 seconds, which means the delay time is shorter compared to Proposal 2. The average queue length is 16.28 meters, which is significantly shorter than the queue length of 84.44 meters in Proposal 2. The Level of Service (LOS) for this scenario is LOS C.

Compared to Proposal 2, Proposal 3 provides better traffic performance with shorter delays and shorter queues, even though both proposals use a 3-phase system. This indicates that the addition of the Left Turn on Red (LTOR) feature in Proposal 3 has a positive impact on traffic flow.

3.5. Comparison of Traffic Performance

Based on the analysis results, the implementation of the proposed solutions shows changes in traffic performance at the Blimbing Three-way intersection. This analysis was conducted by comparing the current traffic condition (existing) with the condition after the proposed solutions were implemented. This comparison helps identify the changes that occurred and determine the best performance after the implementation of the proposal. The evaluation results of the traffic performance comparison provide a detailed picture of the effectiveness of the proposed solutions in improving the flow and efficiency of traffic at the location. Below is the comparison of traffic performance at Blimbing Three-way intersection:

Table 10. Comparison of Traffic Performance Parameters

No	Name	Traffic Performance Parameters		
		Average Vehicle Delay (seconds)	Queue Length (meters)	Level of Service
1	Existing	30,99	26,53	LOS_D
2	Proposal 1 (2 Phase)	20,34	10,37	LOS_C
3	Proposal 2 (3 Phase)	54,72	84,44	LOS_D
4	Proposal 3 (3 Phase + LTOR)	24,05	16,28	LOS_C

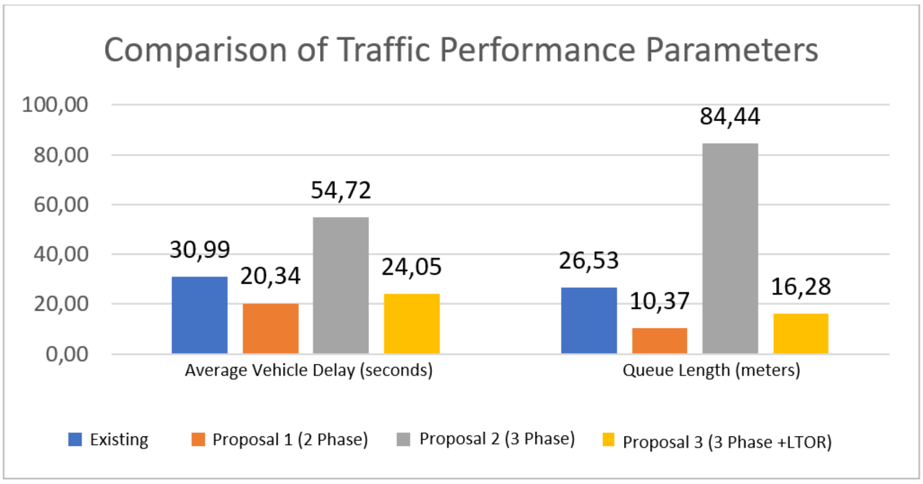

Figure 8. Comparison Diagram of Traffic Performance Parameters

From the three traffic management proposals analyzed, Proposal 3 (Three Phases and Left Turn on Continuous Road) proved to be more optimal with an average vehicle delay of 24.05 seconds and queue length of 16.28 meters which is shorter than Proposal 2 (54.72 seconds and 84.44 meters) and close to the performance of Proposal 1 (20.34 seconds and 10.37 meters), indicating that the addition of the LTOR feature successfully improves traffic flow while maintaining road user safety and Level of Service (LOS C), making it a more effective solution than the other two proposals.

4. Conclusion

The performance analysis of the Blimbing three-way intersection has provided a comprehensive overview of the traffic conditions and potential solutions to enhance efficiency and safety in the area. This conclusion is expected to serve as a solid foundation for stakeholders in formulating policies and strategic actions focused on ensuring sustainable community mobility.

Based on the conducted analysis, it was found that under existing conditions, the highest traffic volume occurs on Sundays, marked by the highest average vehicle delay of 30.99 seconds, a queue length of 26.53 meters, and a Level of Service (LOS) of D, reflecting suboptimal traffic performance. The analysis, which adopted the Australian Road Research Board (ARRB) approach, indicated that the Blimbing three-way intersection requires signalized control (APILL) to enhance traffic flow and safety.

In the first proposed scenario, improvements were observed with an average vehicle delay of 20.34 seconds and a queue length of 10.37 meters, achieving a LOS of C. In the second proposal, which implemented a three-phase signal system, the average delay increased to 54.72 seconds, with an average queue length of 84.44 meters, while the LOS remained at D—indicating traffic conditions approaching capacity limits.

Meanwhile, the third proposal, which incorporated a three-phase system along with a Left Turn on Red (LTOR) feature, delivered more optimal results. It achieved an average delay of 24.05 seconds and a queue length of 16.28 meters. This performance was better than the second proposal and closely matched the first, while maintaining a LOS of C. The inclusion of LTOR proved to improve traffic flow without compromising road user safety, making it a more effective solution compared to the other two alternatives.

As a follow-up recommendation, it is advised to implement adaptive traffic signal technology (APILL) that can dynamically adjust cycle times in real-time based on actual traffic volume and conditions. This would help reduce delays and queue lengths, especially during special occasions such as public holidays. Additionally, installing CCTV is essential for monitoring traffic activity and swiftly identifying issues such as congestion, violations, or accidents. Real-time monitoring will support authorities in taking immediate action to resolve congestion or respond effectively to traffic incidents.

5. References

Balaka, R., & Yudistira, W. (2018). Analisa Model Arus Jenuh Pada Simpang Bersinyal (Studi Kasus: Jl. Drs. H. Abdullah Silondae–Jl. Syech Yusuf–Jl. Lawata). *Jurnal Stabilita, 6 (3)*, 49–54.

BPS. (2024). *Kabupaten Jombang Dalam Angka 2024*. https://jombangkab.bps.go.id/id/publication/2024/02/28/2f68030d8c4ab7d45f3ce759/kabupaten-jombang-dalam-angka-2024.html

Farida, N. A., Nugroho, L. D., & Muhammadun, H. (2025). Road Handling Priority Analysis

Using Provincial/District Roads Management System Application and Analytical Hierarchy Process Method. *INTERNATIONAL JOURNAL ON ADVANCED TECHNOLOGY, ENGINEERING, AND INFORMATION SYSTEM*, *4*(1), 26–39. https://doi.org/10.55047/ijateis.v4i1.1567

Gustavsson, F. N. (2008). New transportation research progress. In *New Transportation Research Progress*.

Hutahaean, Y. G., & Susilo, B. H. (2021). Evaluasi Simpang Bersinyal Taman Sari – Cikapayang Kota Bandung Dengan Analisis VisSim. *Jurnal Teknik Sipil*, *17*(1), 70–87. https://doi.org/10.28932/jts.v17i1.2863

Litman, T. M. (2022). Evaluating transportation equity: Guidance for incorporating distributional impacts in transport planning. *Institute of Transportation Engineers. ITE Journal*, *92*(4), 43–49.

Milanes, V., Alonso, L., Villagrá, J., Godoy, J., de Pedro, T., & Oria, J. P. (2012). Traffic jam driving with NMV avoidance. *Mechanical Systems and Signal Processing*, *31*, 332–344.

Minh, N. P., & Quang, N. M. (2021). Research proposal solutions to anti-flooding for Duong Dinh Cuc Road – Binh Chanh District – Ho Chi Minh City. *Journal of Transportation Science and Technology*, *10*(3). https://doi.org/10.55228/jtst.10(3).79-84

Rodrigue, J.-P. (2020). *The geography of transport systems*. Routledge.

Sassykova, L. R., Aubakirov, Y. A., Sendilvelan, S., Tashmukhambetova, Z. K., Faizullaeva, M. F., Bhaskar, K., Batyrbayeva, A. A., Ryskaliyeva, R. G., Tyussyupova, B. B., & Zhakupova, A. A. (2019). The main components of vehicle exhaust gases and their effective catalytic neutralization. *Oriental Journal of Chemistry*, *35*(1), 110.

St Maryam, H., & Said, L. B. (2021). Analisis Faktor-Faktor Penyebab Kemacetan Persimpangan Jalan di Kota Makassar. *Jurnal Flyover*, *1*(1), 41–49.

Sugiyono. (2017). *Metode Penelitian Penelitian Kuantitatif, Kualitatif dan R&D*. Alfabeta.

Tamin, O. Z. (2000). Perencanaan, Pemodelan, dan Rekayasa Transportasi. In *ITB Press*.

Wesli, W., Akbar, S. J., & Lubis, A. (2022). Evaluasi Jari–Jari Tikungan Jalan (Studi Kasus Simpang Dama Kecamatan Tanah Pasir Kabupaten Aceh Utara). *Teras Jurnal: Jurnal Teknik Sipil*, *12*(2), 449–460.

Zein, F. H., Muhammadun, H., & Marleno, R. (2024). Road Network Simulation Model Analysis Of Pahlawan Road Area With Traffic Management And Engineering Efforts. *INTERNATIONAL JOURNAL ON ADVANCED TECHNOLOGY, ENGINEERING, AND INFORMATION SYSTEM*, *3*(4), 408–421. https://doi.org/10.55047/ijateis.v3i4.1273