



Performance Analysis of Unsignalized Intersections Using PTV VISSIM Software

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Abstract

Traffic congestion is a significant urban problem, often centered on inefficient intersections. This study aims to analyze the performance of the Malalayang Terminal Three Intersection in Manado, which is predicted to experience an increase in traffic volume due to development in the surrounding area. Using a quantitative approach through a case study, this study utilizes microscopic simulation with PTV VISSIM software. Primary data collection was conducted through a three-day field survey (Monday, Wednesday, and Saturday), while secondary data was obtained from relevant literature. The simulation model was validated using Geoffrey E. Havers (GEH) statistics to ensure accuracy. The analysis results show that under existing conditions, the intersection has a level of service (LOS) of B with an average delay of 5.82 to 8.48 seconds and a queue length of 1.52 to 2.57 meters. The evaluation of the handling scenarios proves that widening the road from 7.8 meters to 10 meters is much more effective in improving intersection performance than implementing *signal control*. Widening the road reduced the average delay to 4.98 seconds and the queue to 0.35 meters, while *signal control* actually worsened traffic conditions. Thus, it can be concluded that widening the road is the most optimal solution to overcome traffic problems at this intersection.

Keywords: Traffic Congestion, Road Widening, PTV VISSIM, Traffic Simulation, Unsignalized Intersection

INTRODUCTION

The phenomenon of traffic congestion is a universal problem in urban areas, which not only hinders mobility but also has a significant negative impact on the economy and the environment (Pangestu et al., 2025). The growth in the number of vehicles that is not matched by road infrastructure capacity is the main cause of congestion, which is exacerbated by driving behavior and activities around the road area. This condition often leads to increased fuel consumption and exhaust emissions, which have an impact on air quality and public health (Mahardika et al., 2022). Therefore, a comprehensive solution is needed to manage traffic performance in a sustainable manner.

Intersections, both signalized and unsignalized, are critical locations that are often the main source of conflict and vehicle congestion. Especially at unsignalized intersections, movement efficiency is highly dependent on interactions between drivers, which are often suboptimal, especially during rush hours. The increase in traffic volume due to regional development, such as the construction of the Malalayang Terminal and Malalayang Beach Walk 1 and 2 (MBW 1&2), is predicted to further worsen the performance of the three-way intersection in the area, requiring immediate evaluation and handling (Juwita, 2021; Rifki Rivaldy & Puji Astutik, 2022). An in-depth analysis is needed to understand the existing conditions and identify the most effective mitigation measures.

Considering the complexity of vehicle interactions at intersections, the use of microscopic traffic simulation software is a highly effective approach. PTV VISSIM is one of the leading software programs capable of modeling vehicle behavior in detail and accurately simulating various traffic scenarios (Harianto et al., 2024). The use of simulation allows researchers to test hypotheses and evaluate alternative solutions without the need for costly and risky physical interventions in the field (Juwita, 2021). Thus, simulation is a vital tool in modern transportation planning, helping experts make data-driven decisions.

This study aims to analyze the performance of the Malalayang Terminal intersection using PTV VISSIM and evaluate two main handling scenarios: road geometry widening and traffic light installation. The urgency of this study lies in anticipating the traffic impact of ongoing development, which has the potential to cause severe congestion in the future. The novelty of this research lies in the systematic comparative analysis between two different solution scenarios, the findings of which provide critical insights into the effectiveness of each approach in the specific context of the Malalayang intersection. The results of this study are expected to form the basis for appropriate transportation policy recommendations for authorities to improve traffic efficiency and safety in the area.

METHOD

Type and Method of Research

This research is a quantitative study with a case study approach that focuses on analyzing the performance of unsignalized intersections. Quantitative research was chosen because it involves the collection and analysis of numerical data to test theories and hypotheses (Sugiyono, 2021). The method used is microscopic simulation, which utilizes PTV VISSIM software to model the behavior of individual vehicles and their interactions in the transportation network in detail. This approach allows for accurate and efficient evaluation of traffic performance, as well as testing of problem-handling scenarios without the need for physical intervention in the field (Pangestu et al., 2025). The location of this case study is the Malalayang Terminal intersection, Manado City, North Sulawesi Province, a strategic location that connects the terminal, Sea village, Tateli, and the city center, and is affected by the construction of Malalayang Beach Walk (MBW) (Juwita, 2021).

Data Collection Instruments and Techniques

Data collection was carried out using a combination of primary and secondary data. Primary data was obtained through direct field surveys over three days, namely on weekdays (Monday and Wednesday) and one day off (Saturday), with observations from 05:00 to 21:00 WITA. This survey aimed to capture variations in traffic volume on different days. The data recorded included road geometric conditions (road width and shoulders), traffic flow conditions (vehicle volume by type—heavy, light, motorized, and non-motorized vehicles), and vehicle speed. The instruments used for data collection included manual survey forms, *roll meters* for geometric measurements, and the *Thing Counter* application to calculate vehicle volume. Meanwhile, secondary data was collected from relevant literature, such as journals, books, and articles, to support the theoretical basis and formulas used in the analysis (Sudaryono, 2021).

Research Population and Sample

In this study, the population studied was all traffic passing through the Malalayang Terminal intersection. Meanwhile, the sample was taken from traffic volume data surveyed over three predetermined days, namely Monday, Wednesday, and Saturday. This sample selection was based on the assumption that Monday and Wednesday could represent traffic conditions on weekdays, while Saturday could represent weekend conditions, which tend to have higher vehicle volumes due to its proximity to tourist areas (Rifki Rivaldy & Puji Astutik, 2022). Sampling at different times ensures comprehensive representation of traffic dynamics in the study area.

Research Procedures and Data Analysis

This research procedure was divided into several systematic stages to ensure the validity and accuracy of the results. The stages begin with a preliminary survey to determine the area boundaries and identify intersection characteristics. Next, data processing is carried out using Microsoft Excel and PTV VISSIM software. Primary data obtained from field surveys (geometry, volume, and vehicle speed) are tidied up and recapitulated into a format that can be used for modeling.

Modeling in PTV VISSIM was carried out through the following steps:

1. Data preparation: Entering the collected traffic and geometry data.
2. Network modeling: Creating an intersection model by importing a *background* from Google Earth/Maps, then creating a road network (*links*) and vehicle routes.
3. Traffic data *input*: Enter vehicle volume data, vehicle composition, and *driver* behavior to simulate realistic traffic conditions.
4. Validation and calibration: Before analysis, the model is simulated and validated by comparing the simulation results with actual conditions in the field. The calibration process is carried out to adjust the parameters so that the simulation results are close to the actual conditions. Validity and calibration testing uses Geoffrey E. Havers (GEH) statistics. A model is considered accurate if the GEH value shows a match between the observed data volume (q) and the simulated data volume (Q) (Harianto et al., 2024). The GEH formula is as follows:

$$GEH = \frac{|q - Q|}{\sqrt{q + Q}}$$

After the model is validated, scenario simulations are conducted for existing conditions and two management scenarios (road widening and traffic signal implementation). The results of these simulations are then analyzed to evaluate intersection performance based on key parameters such as average speed, delay, and queue length. This analysis process will provide an in-depth understanding of the effectiveness of each scenario in improving traffic performance at the Malalayang Terminal intersection.

RESULTS AND DISCUSSION

Performance Analysis of Unsignalized Intersections in Existing Conditions Using *PTV VISSIM Software*

Analysis of GEH Results Before Calibration

After running a simulation on PTV VISSIM software for 600 seconds because the author used the student version, the results were obtained in the form of vehicle volume data passing through the road section. This serves as validation or a determinant of whether the analysis that has been carried out can be accepted or rejected, meaning that if the GEH calculation is ≤ 5 , the results are accepted or valid, if $5 < GEH \leq 10$, the model is likely to be poor or contain

errors, and if >10 , it is rejected. The following are the simulation results before calibration:



Figure 1. Simulation Before Calibration

Data Monday, May 25, 2025

Table 1. GEH Results for Monday, May 5, 2025 Volume Data Before Calibration

Vehicle Volume Data Before Calibration Monday, May 5, 2025				Description
Street Name	Survey Data	Vissim Data	Geh	
West Wolter Monginsidi	1362	876	14.53	Error
Wolter Monginsidi East	1908	1398	12.54	Error
Maruasey	317	162	10.02	Error

Table 2. GEH Results Total Volume Data Monday, May 5, 2025 Before Calibration

Total Vehicle Volume Before Calibration Monday, May 5, 2025			Description
Survey Data	Vissim Data	GEH	
3586	2544	18.82	Error

Based on the table above, the simulation results before calibration in the PTV VISSIM software on Monday, May 5, 2025, show that the GEH values on all road sections are still very high, with the highest value reaching 18.82 for the total number of vehicles, and on Jalan W. Monginsidi Barat reaching 14.53, Jalan W. Monginsidi Timur reaching 12.54, and Jalan Maruasey reaching 10.02. This indicates that the simulation results are not yet in line with the survey data, so a calibration process is needed until the GEH value is <5 so that the analysis results are considered valid and accurate.

Data Wednesday, May 7, 2025

Table 3 GEH Results for Wednesday, May 7, 2025, Before Calibration

Vehicle Volume Data Before Calibration Wednesday, May 7, 2025				Description
Street Name	Survey Data	Vissim Data	Geh	
West Wolter Monginsidi	1635	1158	12.76	Error
East Wolter Monginsidi	1265	870	12.09	Error
Maruasey	295	156	9.26	Possible Error

Table 5. GEH Results Total Volume Data Monday, May 5, 2025 Before Calibration

Total Volume Vehicles Before Calibration Wednesday, May 7, 2025			Description
Survey Data	Vissim Data	GEH	
3195	2280	17.49	Error

Based on the table above, the simulation results before calibration in the PTV VISSIM software on Wednesday, May 7, 2025, show that the GEH values on all road sections are still very high, with the highest value reaching 17.47 for the total number of vehicles, and on Jalan W. Monginsidi Barat reaching 12.76, Jalan W. Monginsidi Timur reaching 12.09, and Jalan Maruasey reaching 9.26. This indicates that the simulation results are not yet consistent with the survey data, so a calibration process is needed until the GEH value is <5 so that the analysis results are considered valid and accurate.

Data Saturday, May 10, 2025

Table 6 GEH Results for Saturday, May 10, 2025 Vehicle Volume Data Before Calibration

Vehicle Volume Data Before Calibration Saturday, May 10, 2025				Description
Street Name	Survey Data	Vissim Data	Geh	
West Wolter Monginsidi	1244	966	8.36	Possible Error
Wolter Monginsidi East	1310	966	10.20	Error
Maruasey	318	156	10.52	Error

Table 7 GEH Results Total Volume Data Saturday, May 10, 2025 Before Calibration

Total Vehicle Volume Before Calibration Saturday, May 10, 2025			Description
Survey Data	Vissim Data	GEH	
2872	2208	13.18	Error

Based on the table above, the simulation results before calibration in the PTV VISSIM software on Saturday, May 10, 2025, show that the GEH values on all road sections are still very high, with the highest value reaching 13.18 for the total number of vehicles, and on Jalan W. Monginsidi Barat reaching 8.36, Jalan W. Monginsidi Timur reaching 10.20, and Jalan Maruasey reaching 10.52. This indicates that the simulation results are not yet in line with the survey data, so a calibration process is needed until the GEH value is <5 so that the analysis results are considered valid and accurate.

Analysis of GEH Results After Calibration

After the calibration process, a Running Simulation was conducted on the PTV VISSIM Software for 600 seconds because it uses the Student Version. The modeling results for volume and speed were close to or in line with the field conditions. The following are the simulation results after calibration:

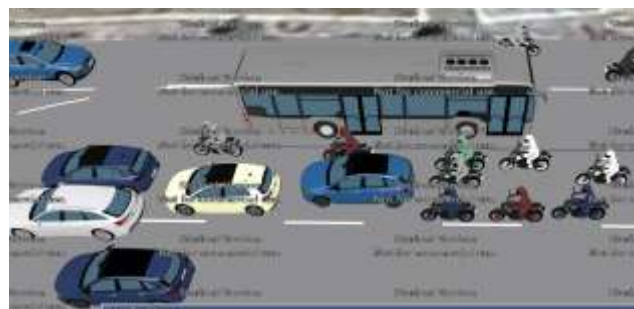


Figure 2. Simulation After Calibration

Data Monday, May 25, 2025

Table 8 GEH Results for Volume Data on Monday, May 5, 2025, After Calibration

Vehicle Volume Data After Calibration Monday, May 5, 2025				Description
Street Name	Survey Data	Vissim Data	Geh	
West Wolter Monginsidi	1362	1326	0.98	Accepted
Wolter Monginsidi East	1908	1908	0.00	Accepted
Maruasey	317	336	1.05	Accepted

Table 9 GEH Results Total Volume Data Monday, May 5, 2025 After Calibration

Total Vehicle Volume After Calibration Monday, May 5, 2025			Notes
Survey Data	Vissim Data	Geh	
3586	3570	0.27	Accepted

Based on the table above, the simulation results after calibration on vehicle volume data on Monday, May 5, 2025, obtained a GEH value of <5 on all analyzed road sections. The highest GEH value was only 1.05, which means that all calibration data was accepted according to the standard. The total vehicle volume from the simulation also aligns with the survey data, with a total GEH value of only 0.27, so the calibration results are considered valid and accurate.

Data for Wednesday, May 7, 2025

Table 10 GEH Results for Wednesday, May 7, 2025 Vehicle Volume Data After Calibration

Vehicle Volume Data After Calibration Wednesday, May 7, 2025				Description
Street Name	Survey Data	Vissim Data	Geh	
West Wolter Monginsidi	1635	1596	0.97	Accepted
Wolter Monginsidi East	1265	1212	1.51	Accepted
Maruasey	295	290	0.29	Accepted

Table 11 GEH Results Total Volume Data Wednesday, May 7, 2025 After Calibration

Total Vehicle Volume After Calibration Wednesday, May 7, 2025			Description
Survey Data	Vissim Data	GEH	
3195	3156	0.69	Accepted

Based on the table above, the simulation results after calibration of vehicle volume data on Wednesday, May 7, 2025, obtained a GEH value of <5 on all analyzed road sections. The highest GEH value was only 1.51, which means that all calibration data was accepted according to the standard. The total vehicle volume from the simulation also matches the survey data, with a total GEH value of only 0.69, so the calibration results are considered valid and accurate.

Data for Saturday, May 10, 2025

Table 12 GEH Results for Saturday, May 10, 2025 Vehicle Volume Data After Calibration

Vehicle Volume Data After Calibration Saturday, May 10, 2025				Description
Street Name	Survey Data	Vissim Data	Geh	
West Wolter Monginsidi	1244	1176	1.95	Accepted
Wolter Monginsidi East	1310	1272	1.06	Accepted
Maruasey	318	348	1.64	Accepted

Table 13 GEH Results Total Volume Data Saturday, May 10, 2025 After Calibration

Total Vehicle Volume After Calibration Saturday, May 10, 2025			Description
Survey Data	Vissim Data	GEH	
2872	2694	3.37	Accepted

Based on the table above, the simulation results after calibration on vehicle volume data on Saturday, May 10, 2025, obtained a GEH value of <5 on all analyzed road sections. The highest GEH value was only 1.95, which means that all calibration data was accepted according to the standard. The total vehicle volume from the simulation also matches the survey data, with a total GEH value of only 3.37, so the calibration results are considered valid and accurate.

Existing Vehicle Delay

Based on the PTV VISSIM software simulation results, the vehicle delay value indicates the level of traffic congestion occurring on the road section. The greater the delay value, the lower the level of service on that road. This data is existing road condition data at the Malalayang Terminal T-junction, and the average delay value from 10 runs in the PTV VISSIM software was taken.

Delay Data Monday, May 5, 2025**Table 14: Existing Delay Conditions on Monday, May 5, 2025**

No	Road Network	Delay (sec)	Level of Service (LOS)
1	W. Monginsidi Timur Road - W. Monginsidi Barat Road	2.4	A
2	East W. Monginsidi Street - Maruasey Street	10.69	B
3	W. Monginsidi West Street - W. Monginsidi East Street	0.61	A
4	W. Monginsidi West Street - Maruasey Street	9.19	B
5	Maruasey Street - W. Monginsidi Timur Street	18.37	C
6	Maruasey Street - W. Monginsidi West Street	9.56	B
	Average	8.48	B

Based on the table above, the results of the delay analysis from the PTV VISSIM software at the Malalayang Terminal T-junction show an average delay of 8.48 seconds with a level of service (LOS) of B, which indicates that the traffic conditions at this intersection are quite good. The highest delay occurred on the Maruasey Road – W. Monginsidi Timur Road movement with a value of 18.37 seconds (LOS) C, while the lowest delay was found on the W. Monginsidi

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Barat Road – W. Monginsidi Timur Road with a value of 0.61 seconds (LOS) A. Overall, this intersection is still able to serve traffic flow well because it has a service level (LOS) B.

Delay Data Wednesday, May 7, 2025

Table 15: Existing Delay Conditions on Wednesday, May 7, 2025

No	Road Network	Delay (sec)	Level of Service (LOS)
1	W. Monginsidi East Road - W. Monginsidi West Road	0.8	A
2	W. Monginsidi East Street - Maruasey Street	4.19	B
3	W. Monginsidi West Street - W. Monginsidi East Street	0.73	A
4	W. Monginsidi West Street - Maruasey Street	12.16	B
5	Maruasey Street - W. Monginsidi Timur Street	1:30	B
6	Maruasey Street - W. Monginsidi West Street	11:31	B
	Average	7.09	B

Based on the table above, the results of the delay analysis from the PTV VISSIM software at the Malalayang Terminal T-junction show an average delay of 7.09 seconds with a level of service (LOS) of B, which indicates that the traffic conditions at this intersection are quite good. The highest delay occurred on the Maruasey Road – W. Monginsidi Timur Road movement with a value of 13.30 seconds (LOS) B, while the lowest delay was found on the W. Monginsidi Barat Road – W. Monginsidi Timur Road with a value of 0.73 seconds (LOS) A. Overall, this intersection is still able to serve traffic flow well because it has a service level (LOS) B.

Delay Data Saturday, May 10, 2025

Table 16 Existing Delay Conditions Saturday, May 10, 2025

No	Road Network	Delay (Det)	Level of Service (LOS)
1	W. Monginsidi East Road - W. Monginsidi West Road	1.1	A
2	W. Monginsidi East Street - Maruasey Street	5.78	B
3	W. Monginsidi West Street - W. Monginsidi East Street	0.56	A
4	W. Monginsidi West Street - Maruasey Street	9.67	B
5	Maruasey Street - W. Monginsidi East Street	12.43	B
6	Maruasey Street - W. Monginsidi Barat Street	5.34	B

Average	5.82	B
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Based on the table above, the results of the delay analysis from the PTV VISSIM software at the Malalayang Terminal T-junction show an average delay of 5.82 seconds with a level of service (LOS) of B, which indicates that the traffic conditions at this intersection are quite good. The highest delay occurred on the Maruasey Road – W. Monginsidi Timur Road movement with a value of 12.43 seconds (LOS) B, while the lowest delay was found on the W. Monginsidi Barat Road – Jln W. Monginsidi Timur with a value of 0.56 seconds (LOS) A. Overall, this intersection is still able to serve traffic flow well because it has a level of service (LOS) B.

Existing Queue Length (Qlen)

Vehicle queue length (Qlen) Based on the results of the PTV VISSIM software simulation, calculated to identify the potential for congestion at intersections, a higher Qlen value indicates obstacles and vehicle slowdowns due to road capacity that is insufficient for the volume of incoming vehicles.

Queue Length Data for Monday, May 5, 2025

Table 17 Existing Queue Length on Monday, May 5, 2025

No	Road Network	Queue Length (M)	
		Qlen	Qlenmax
1	W. Monginsidi East Road - W. Monginsidi West Road	1.66	19.68
2	W. Monginsidi East Street - Maruasey Street	3.06	23.64
3	W. Monginsidi West Street - W. Monginsidi East Street	0.09	4.64
4	W. Monginsidi West Street - Maruasey Street	0.25	6.32
5	Maruasey Street - W. Monginsidi East Street	5.37	30.89
6	Maruasey Street - W. Monginsidi Barat Street	4.98	34.40
Average		2.57	19.93

Based on the table above, the length of the existing queue analyzed using PTV VISSIM software on Monday, May 5, 2025, the average vehicle queue length is 2.57 meters, with an average maximum queue length of 19.93 meters (). The longest queue point was on the Maruasey Road - W. Monginsidi Timur Road section with a queue length of 5.37 meters, and the shortest queue length was on the W. Monginsidi Barat Road - Monginsidi Timur Road section with a queue length of 0.09 meters. The longest maximum queue was located on the Maruasey Street – West Monginsidi Street section, measuring 34.40 meters, and the shortest maximum queue was located on the West W. Monginsidi Street – East W. Monginsidi Street section, measuring 4.64 meters.

Queue Length Data Wednesday, May 7, 2025

Table 18: Existing Queue Lengths on Wednesday, May 7, 2025

No	Road Network	Queue Length (M)	
		Qlen	Maximum Qlen
1	W. Monginsidi East Road - W. Monginsidi West Road	0.25	15.14

2	W. Monginsidi East Street - Maruasey Street	0.45	16.59
3	W. Monginsidi West Street - W. Monginsidi East Street	0.20	20.93
4	W. Monginsidi West Street - Maruasey Street	0.20	20.93
5	Maruasey Street - W. Monginsidi East Street	4.66	34.66
6	Maruasey Street - W. Monginsidi Barat Street	3.83	34.27
Average		1.60	23.75

Based on the table above, the length of the existing queue analyzed using PTV VISSIM software on Wednesday, May 7, 2025, the average vehicle queue length is 1.60 meters, with an average maximum queue length of 23.75 meters. The longest queue point was on the Maruasey Road - W. Monginsidi Timur Road section with a queue length of 4.66 meters, and the shortest queue length was on the W. Monginsidi Barat Road - Monginsidi Timur Road section with a queue length of 0.20 meters. The longest maximum queue was located on the Maruasey Street – West Monginsidi Street section, measuring 34.27 meters, and the shortest maximum queue was located on the West W. Monginsidi Street – East W. Monginsidi Street section, measuring 20.90 meters, the same as the West W. Monginsidi Street – Maruasey Street section.

Queue Length Data Saturday, May 10, 2025

Table 19: Existing Queue Length on Saturday, May 10, 2025

No	Road Network	Queue Length (M)	
		Qlen	Qlenmax
1	W. Monginsidi East Road - W. Monginsidi West Road	1.07	10.23
2	W. Monginsidi East Street - Maruasey Street	1.56	12.10
3	W. Monginsidi West Street - W. Monginsidi East Street	0.28	2.76
4	W. Monginsidi West Street - Maruasey Street	0.49	4.41
5	Maruasey Street - W. Monginsidi Timur Street	3.56	24.19
6	Maruasey Street - W. Monginsidi West Street	2.18	19.08
Average		1.52	12.13

Based on the table above, the length of the existing queue analyzed using PTV VISSIM software on Saturday, May 10, 2025, the average vehicle queue length is 1.52 meters, with an average maximum queue length of 12.13 meters. The longest queue was found on the Maruasey Road - W. Monginsidi Timur Road section with a queue length of 3.56 meters, and the shortest queue was found on the W. Monginsidi Barat Road - Monginsidi Timur Road section with a queue length of 0.28 meters. The longest maximum queue was located on the Maruasey Street – East Monginsidi Street section, measuring 24.19 meters, and the shortest maximum queue was located on the West W. Monginsidi Street – East W. Monginsidi Street section, measuring 2.76 meters.

CONCLUSION

Based on the analysis of the performance of unsignalized intersections using PTV VISSIM software, this study concludes that the Malalayang Terminal T-junction as a whole has fairly good performance, with a level of service (LOS) of B under existing conditions. The main findings show that the road widening scenario proved to be much more effective in improving intersection performance than the installation of signal control. Widening the road from 7.8 meters to 10

meters successfully reduced the average delay significantly from 8.48 seconds to 4.98 seconds and reduced the queue length from 2.57 meters to 0.35 meters. Conversely, the installation of signal control actually increased the average delay to 15.40 seconds and the queue length to 14.48 meters, indicating that this solution was not optimal for the characteristics of the intersection.

However, this study has limitations, particularly regarding the use of the Student version of PTV VISSIM, which limits the duration of the simulation, which may affect the accuracy of the data over a longer period of time. Therefore, it is recommended that future research compare VISSIM simulation results with other manual methods commonly used in Indonesia, such as the Indonesian Road Capacity Manual (MKJI) and the Indonesian Road Capacity Guidelines (PKJI), to validate and enrich the findings. Furthermore, based on its effectiveness, this study strongly recommends that the authorities prioritize the option of widening the Maruasey Road section to optimize intersection performance in the long term.

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