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Model Simulation of Holiday Session Traffic Flow at Three Ways Intersection in Indonesia

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A B S T R A C T

Traffic density increases fluctuatively during holidays due to rising tourist activities, requiring seasonal traffic management. This study analyzes the impact using PKJI 2023 and PTV VISSIM modeling. At peak hour, the intersection shows a degree of saturation (DS) = 0.776 and average delay = 13.075 sec/MPH with LOS B. Projections for the next 5–10 years indicate DS = 1.10 and delay = 25.234 sec/MPH with LOS D. Of three modeled alternatives, the best is Alternative 2: diverting major north-south traffic to the east minor road, resulting in average speed = 23 km/h, delay = 14.075 sec/MP, queue length = 16.417 m, and LOS B.

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INTRODUCTION

Traffic congestion escalates during holiday seasons due to increased tourist activity, necessitating seasonal traffic management. Unaddressed, this congestion negatively impacts the economy, as efficient transportation is vital for economic growth (Eddington & Stationery Office Great Britain, 2006, in Khreis et al., 2016).

A primary cause is holiday-induced traffic surges. Official holidays have a defined duration, but their impact on traffic patterns, emissions, and air pollution can linger (Xiang et al., 2024). Traffic volumes can increase by up to 1.5 times normal levels during these periods, a globally observed phenomenon (Çolak et al., 2016; Liu & Sharma, 2006; Bao et al., 2017).

Rising interest in travel during holidays significantly impacts daily travel patterns (Liu et al., 2020). While some holidays might improve traffic performance on specific days (Ratnapradipa & Zhu, 2020), holiday seasons often worsen congestion and accident rates. In Indonesia, specifically Christmas and New Year, consistently drive increased travel, leading to recurring intersection traffic problems annually (Yaqin & Khasna, 2024).

LITERATURE REVIEW

Intersection

Road intersections are crucial for managing traffic flow but are often sources of congestion when volumes exceed capacity. For instance, the Karangploso tri-intersection in Malang Regency (Faradhika et al., 2025), an unsignalized intersection, showed suboptimal performance with a degree of saturation of 1.18 and a delay of 35.78 seconds/smp during peak hours, highlighting the need for intervention. Similarly, Fatmawati intersection (Iin Irawati et al., 2024) experienced peak flows up to 589.7 smp/h, with approach saturation degrees between 0.48 and 0.58, and a 93-meter queue length, resulting in a Level of Service (LOS) C. These examples underscore the common challenge of maintaining efficient traffic flow at intersections.

Holiday Season

The phenomenon of increased traffic volumes during special periods, such as national holidays and long holidays, underscores the fundamental limitations in the existing traffic management system. A study (Nugroho & Setiawan 2023) showed a 41% reduction in capacity at the Lembang tourist area intersection during long holidays due to the absence of an adaptive traffic prioritization system. This data implies an urgent need for a predictive and contextual traffic management approach, not just a reactive one. Holiday periods are an integral part of people's mobility patterns that must be anticipated within the framework of long-term transportation policy.

Micro Simulation

Traffic modeling provides a safe, experimental space to simulate various vehicle movement scenarios and evaluate policy interventions without disrupting real traffic. Studies (Wang & Liu, 2023) highlight its ability to replicate individual driver behavior in real-time, offering a more realistic picture than conventional models. Integrating predictive models, like the FD-Markov-LSTM model which showed over 35% RMSE reduction (Pan et al., 2023), is crucial for transportation planning. However, effective modeling relies on high-quality, representative data and integration into a policy framework prioritizing efficiency, safety, and sustainability.

Various simulation software tools, including SUMO, AIMSUN, Paramics, VISSIM, and PTV VISSUM, use cellular automata to visualize traffic flows interactively. These visualizations are vital for identifying congestion points and adaptively testing management strategies (Trapeznikova et al., 2024).

PTV VISSIM

PTV VISSIM offers significant academic and technical contributions to urban traffic and transportation engineering in Indonesia. Academically, it enables realistic microsimulations that capture local driver behavior, complementing empirical models like PKJI 2023. This study demonstrates VISSIM's adaptability to local conditions, supporting the development of context-specific driver behavior models, a current gap in Indonesian transportation studies (e.g., Mulyadi & Adawiyah, 2024; Faradhika et al., 2025).

Technically, VISSIM provides accurate, real-data based modeling validated by GEH < 5 criteria, crucial for policy decisions. It facilitates long-term performance projections (5-10 years), essential for sustainable planning. Furthermore, VISSIM allows safe, detailed evaluation of alternative traffic schemes, identifying effective solutions like flow diversions that significantly improve traffic metrics. Its high contextual relevance to Indonesian conditions, including unsignalized intersections and aggressive driving, makes it an ideal evidence-based planning tool for developing countries.

These findings are consistent with previous research, reinforcing VISSIM's role in providing accurate analyses for unsignalized intersections (Mulyadi & Adawiyah, 2024), informing redesigns for peak traffic (Faradhika et al., 2025), and optimizing schemes to reduce congestion (Sun et al., 2024; Chen, 2023). VISSIM also aids in developing safer solutions for challenging intersections where minor roads struggle to merge (Road et al., 2023). Thus, PTV VISSIM contributes significantly to both the methodology and data-driven policy application in Indonesian transportation engineering.

METHODOLOGY

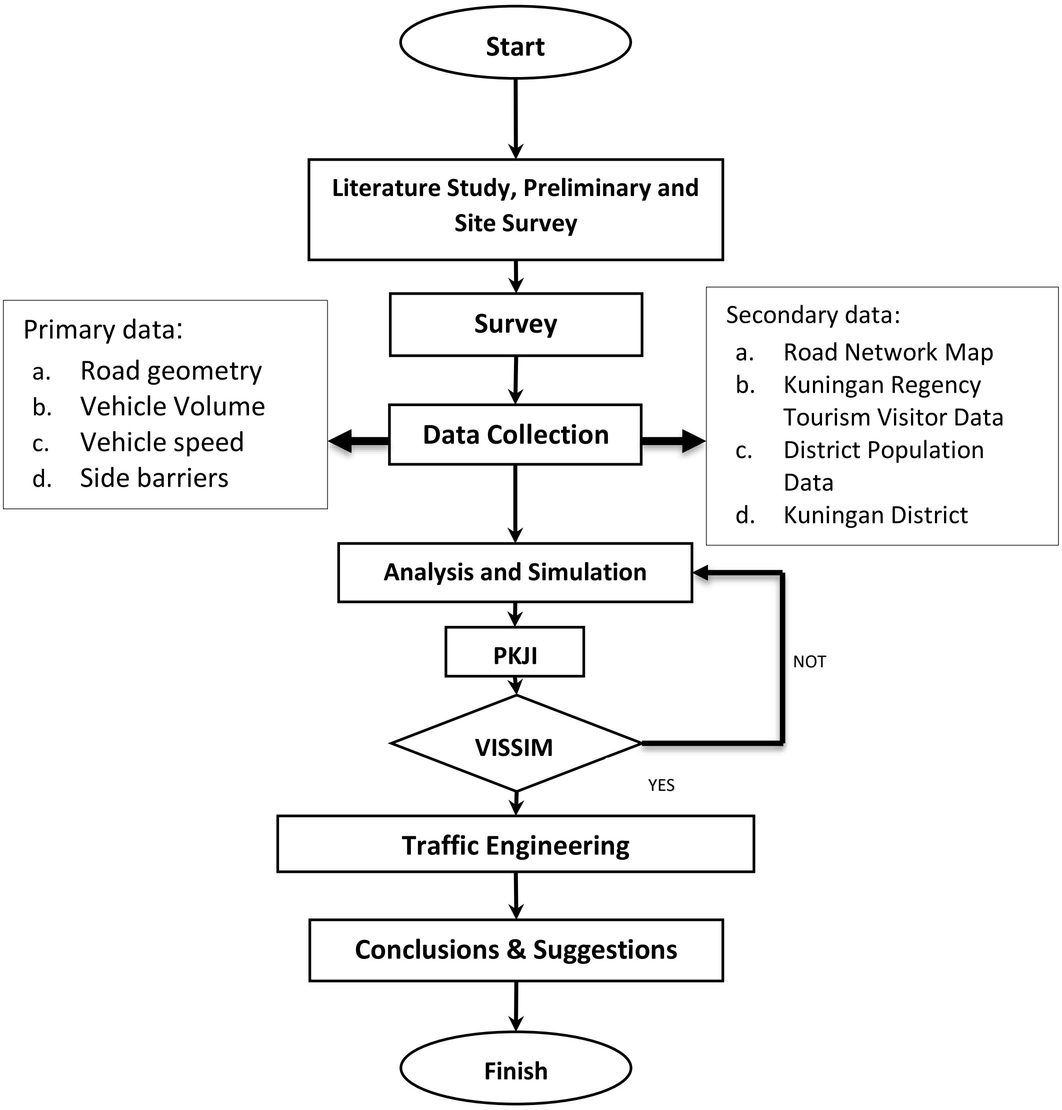

Figure 1. Research Flow

Data Collection

This research requires data in the form of primary data and secondary data. Primary data is obtained from the results of surveys in the field for eight days from 06.00 - 18.00 WIB. Primary data needed in the research to be carried out are: traffic volume data, road geometric data, speed data, side obstacle data, and environmental conditions, while. Secondary data is obtained from journals, articles, and Indonesian Road Capacity Guidelines 2023 (PKJI 2023).

Data Analysis

The entire data analysis used Microsoft Excel 2019 software. Data analysis is carried out by calculating the survey data that has been obtained and then entered according to the intersection performance formula that refers to the Indonesian Road Capacity Guidelines (PKJI 2023). Furthermore, analysis will be carried out in various aspects, namely analyzing traffic volume, vehicle speed, side obstacles, and road capacity. Based on PKJI 2023, the calculation results of the main traffic parameters such as degree of saturation (DJ), delay (T) that occurs due to traffic flow, as well as queuing opportunities (Pa) and can determine the level of traffic service or LoS (Level of Service) at an intersection,

Based on the Service Level Characteristics according to Ministerial Regulation No. 96/2015, it can be seen in Table 1.

Table 1. Service Level Based on Delay (T)

Service level	Average Vehicle Delay (seconds)	Notes.
A	< 5.0	Very good
B	> 5.1 -15.0	Good.
C	> 15.1 - 25.0	Maintain
D	> 25.1 - 40.0	Less
E	> 40.1 - 60.0	Bad
F	> 60.1	Very Bad

Vehicle Growth Rate Factor

From the data on vehicle growth in Kuningan Regency every year has increased, proving that the increase in vehicles every year will affect the volume of vehicles at the intersection. Steps to calculate the vehicle growth rate factor for each type of vehicle with the following equation.

$$\mathbf{CAGR\ \% = \left(\frac{Nilai_{2024}}{Nilai_{2020}}\right)^{\frac{1}{4}} - 1 \times 100}$$

The percentage increase in tourists or visitors can be calculated based on the following equation.

$$\mathbf{i = \frac{y_2 - y_1}{y_1} \times 100\%}$$

Modeling

This VISSIM traffic modeling aims to recommend effective traffic engineering solutions for Indonesian national holiday congestion. Using traffic and intersection geometric data, the simulation will propose optimal routes, providing local government with actionable strategies. The model accounts for real-world traffic variability to accurately predict intersection performance

Research Location

Fig. 1. Research Location

This research location is located at Kuningan Tugu Ikan, Ciperna highway, Sampora Village, Cilimus District, Kuningan Regency, West Java Province, Indonesia 45556. For locations at coordinates -6.8492488, 108.5081263. 5G25+872 Sampora, Kuningan Regency, West Java.

RESEARCH RESULTS AND DISCUSSION

Road Geometry Condition

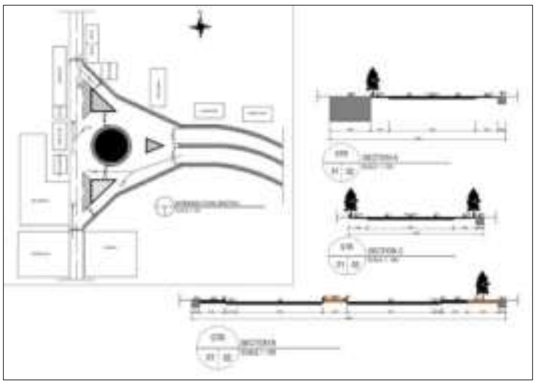

Fig. 2. Geometric Intersection

Here's a concise description of the geometric characteristics for each arm of the intersection:

Arm A (Cilimus Road from Cirebon): This arm features a 7-meter lane width (3.5 meters per lane), with a 1.85-meter right shoulder, a 1.5-meter left shoulder, and respective drainage widths of 0.6 meters and 3.3 meters.

Arm B (Kuningan East Ring Road from the East): This arm is 14 meters wide (7 meters per lane) and includes a 2-meter median. It also has a 2-meter shoulder, a 2-meter sidewalk on the left, 0.6-meter drainage, and a 2.53-meter park on the right.

Arm C (Cilimus Road towards the Government Center): This arm has a 7-meter lane width (3.5 meters per lane). It's equipped with 1.5-meter and 1.85-meter shoulders, a 2-meter sidewalk on the left, and 0.6-meter drainage on the right.

Intersection Environment

From the observations at the research location, the intersection of Tugu Ikan Sampora, Ciperna – Cilimus highway and Kuningan east ring road is a triple intersection with intersection type 322. The type of intersection environment reviewed when viewed from the criteria in the PKJI 2023 table shows that the type of environment around the study area is included in the commercial environment.

Traffic Volume (Q_{TOTAL}) and Capacity (C) of Intersection

The traffic volume data to be used in the calculation is the traffic volume during peak hours or the highest traffic volume that has been obtained. The survey was conducted for 8 days in December, before the Holiday season and during the National Holiday season in Indonesia. Based on the results of the survey that has been carried out, the traffic volume of the Kuningan Tugu Ikan three intersection, Ciperna highway, Sampora Village, Kuningan Regency, West Java, is as follows.

Fig. 3. Pre-Holiday Season Traffic Volume Chart (SMP/Hour)

From the traffic volume data before the Christmas and New Year holiday season at Tugu Ikan Intersection, Kuningan Regency, it was found that the peak hour was at 14.00 - 15.00 with a vehicle volume of 1914.2 SMP / hour.

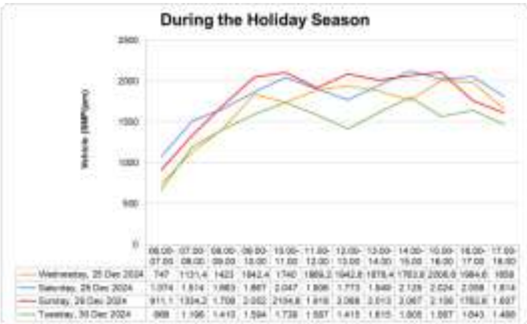

Fig. 4. Chart of Traffic Volume During Holiday Season (SMP/Hour)

From the traffic volume data before the Christmas and New Year holiday season at the Tugu Ikan Three Intersection, Kuningan Regency, the peak hour was obtained at 14.00 - 15.00 with a vehicle volume of 2,125 smp / hour. From the traffic volume obtained, then the calculation of the intersection capacity is based on the factors in table 2. The following are the results of the calculation of the intersection capacity.

Table 2. Capacity Determination Correction Factor

No.	Factor	Value	Note
1	Base Capacity (C_0)	2700	The three Tugu Ikan intersection has arms with 4 lanes on the minor road and 2 lanes on the major road. The intersection should be type 342 but there are limitations in the Standard set by PKJI 2023, therefore we use intersection type 322 which is close to the classification of the intersection type.
2	Average Approach Width Correction (F_{LP})	1.072	Calculated using LRP and the formula: FLP = 0.73 + 0.0760 x LRP (LRP =4.5)
3	Median Correction on Main Road (F_M)	1	Determined by the table of Median Correction Factors on Main Roads and at intersections where there is no median on the main road.
4	City Size Correction (F_{UK})	1	Based on the Correction Factor table for the city area and population, Kuningan Regency is included in the large category with a population of 1,213,927 people.
5	Side Obstacle Correction (F_{HS})	0,930	Determined by commercial road environment type class, high side obstacle class, and 0.000 RKTB
6	Left Turn Flow Correction (F_{BKi})	1.173	Calculated using the equation FBKi = 0.84 + 1.61 RBKi (RBKi = 0.207)
7	Right Turn Flow Correction ($F_{(BKa)}$)	0,893	Calculated using the equation FBKa = 1.09 - 0.922 RBKa (RBKa = 0.213)
8	Minor road flow correction (F_{Rmi})	0,972	Intersection type 322 and Rmi = 0.242. Calculated using the equation Fmi = 1.19 x Rmi^2 - 1.19 x Rmi + 1.19

Intersection Operational Performance

Traffic performance at three intersections on holidays, then a quantitative analysis is carried out based on survey data in the field guided by PKJI 2023. presented in Table 3. below.

Table 3. Current Intersection Operational Performance

Existing Operational Performance Of The Intersection								
Time	Total traffic flow Qtot	Degree of Saturation	Traffic Junction Delays	Major Road Traffic Delays	Minor Cross Road Delay	Intersection Geometry Delay	Intersection Delay	Queue Opportunities
	SMP/ hour	Dj	TLL	TLL	TLLmi	TG	T=TLL +TG	Pa
Before The Holiday Season	1913	0,639	7,182	5,012	18,149	4,065	11,247	17-35%
During The Holiday	2125	0,775	9,016	6,398	17,207	4,058	13,075	24-49%

Before the holiday season, the intersection experienced a traffic flow of 1913 smp/hour and a degree of saturation (DJ) of 0.639. The total intersection delay was 11.247 seconds/smp, resulting in a Level of Service (LOS) of D, with queuing probabilities between 17% and 35%. During the holiday season, traffic flow increased to 2125 smp/hour with a DJ of 0.775. The total intersection delay rose to 13.075 seconds/smp, maintaining an LOS of D, but with higher queuing probabilities ranging from 24% to 49%. These findings align with Ministerial Regulation No. KM 96 of 2015.

Operational Performance for the Next 5 - 10 Years

To forecast future intersection performance over the next 5-10 years, we're analyzing vehicle growth trends. This involves regressing historical data to determine annual growth rates for five vehicle types: Motorcycles (SM), Passenger Cars (MP), Medium Buses and Goods Trucks (KS), Large Buses (BB), and 3-Axle/Double/Outboard Trucks (TB). Predicting transportation growth is crucial as traffic volume directly correlates with vehicle population increases. Kuningan Regency's consistent vehicle growth confirms its future impact on the Tugu Ikan Intersection's traffic. Specific growth rates are detailed in Table 4.

Table 4. Vehicle Growth Per Year (i%) Kuningan Regency

Brass Vehicle Growth Data						
Year	Vehicle Type					
	KS	MP	BB	TB	SM	Total
2020	25707	25707	797	8556	301300	336360
2021	26843	26843	750	8698	303618	339909
2022	28238	28238	599	8926	307202	344965
2023	29525	29525	569	9079	313328	352501
2024	30168	30168	568	9084	313928	353748
CAGR	4,08%	4,08%	-8,12% 0,52%	1,51%	1,03%	

The results of data analysis of the average growth percentage of Kuningan Regency vehicles is 0.52%. per year. After obtaining the percentage growth of each type of vehicle, the traffic volume is projected to determine the performance of the intersection for the next 5 to 10 years. This can be seen in table 5. The following.

Table 5. Growth Rate of Each Type of Motorized Vehicle in Kuningan Regency

		Growth Rate of Each Type of Vehicle in Kuningan Regency			
2024		5-Year Projection		10-Year Projection	
		Vehicle/hour	Junior High/Hours	Vehicle/hour	Junior High/Hours
SM	1322	1391,618	278,324	1464,903	292,981
MP	1475	1801,611	1801,611	2200,543	2200,543
KS	178	217,415	391,346	265,557	478,003
BB	23	15,061	27,109	9,862	17,751
TB	13	14,010	25,219	15,099	27,179
KTB	0	0	0,000	0,000	0,000
Q_{Total}	3011	3439,714	2523,608	3955,964	3016,456

Traffic volume at the Kuningan intersection is projected to increase significantly across most vehicle types over the next decade. By 2029 (5-year projection), motorcycle volume is expected to rise from 1322 to 1391.618 vehicles/hour, passenger cars from 1475 to 1801.611 vehicles/hour, medium vehicles from 178 to 217.415 vehicles/hour, and large trucks from 13 to 14.010 vehicles/hour. Large bus volume, however, is projected to decrease from 23 to 15.060 vehicles/hour. The total traffic volume (Q Total) in vehicles/hour for 2029 is projected at 3439.714, equivalent to 2523.608 SMP/hour. Looking further to 2034 (10-year projection), motorcycle volume will reach 1469.903 vehicles/hour, passenger cars 2200.543 vehicles/hour, medium vehicles 265.557 vehicles/hour, and large trucks 15.099 vehicles/hour. Large bus volume is projected to further decrease to 9.068 vehicles/hour. The overall Q Total for 2034 is estimated at 3955.964 vehicles/hour, which translates to 3016.456 SMP/hour. These figures highlight a substantial rise in overall traffic, particularly for private vehicles, posing future challenges for the intersection.

The following are the results of the 5 - 10 year calculation obtained by the Degree of Saturation (D_J)and the intersection level of service (LoS) delay, which can be seen in Table 6.

Table 6. Growth Rate of Each Type of Vehicle in Kuningan Regency

Year To	Plan Year	Q (SMP/Hour)	Capacity (C) (SMP/Hour)	Degree of saturation (D_J)	Delay (T)	Service Level Based on Delay (T)

5	2029	2523,608	2739,8	0,92	16.213	C
10	2034	3016,456	2739,8	1,1	25.234	D

Projections indicate a significant decline in the performance of Kuningan's Sampora Tugu Ikan Intersection over the next decade, leading to exacerbated congestion and economic disruption.

By 2029 (5-year projection), Traffic Volume (Q Total) is expected to reach 2523.608 smp/hour, with a Degree of Saturation (DJ) of 0.92. The intersection's service level, based on Ministerial Regulation No. 96 of 2015, is projected to be Category C (sufficient), with a delay of 16.213 seconds/smp. By 2034 (10-year projection), Traffic Volume is projected at 3016.456 smp/hour, with a DJ of 1.10. This indicates a Category D (low) service level, with delays increasing to 25.234 seconds/smp. This decline signifies that without intervention, the intersection will experience severe congestion, negatively impacting local activities and the economy.

Therefore, immediate evaluation and implementation of effective traffic management solutions are crucial, especially during national holidays, to improve intersection performance.

Tourism Analysis

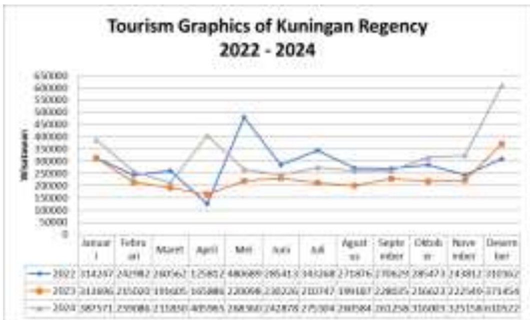

Fig. 5. Tourism Traffic Chart of Kuningan Regency

Kuningan Regency has experienced significant fluctuations in tourist numbers over recent years. While 2022 saw 3,434,925 tourists, there was a dip to 2,785,126 in 2023, followed by a substantial increase to 3,824,519 tourists in 2024.

A consistent and notable surge in tourism occurs every December, primarily driven by the Christmas and New Year holidays. Unlike other major holidays like Eid al-Fitr (Lebaran), which vary annually based on the Islamic calendar, Christmas and New Year fall on fixed Gregorian calendar dates. This predictability leads to a reliable annual increase in visitors to Kuningan Regency during this specific period.

Fig. 6. Graph of Regency Percentage (%) Increase in the Number of Tourists per Month in Kuningan Regency in 2022 - 2023

Data indicates a consistent average increase of 60.67% in vehicle volume during December, directly linked to the Christmas and New Year holiday season. This is evidenced by a significant jump in total traffic volume (Q Total) at the Kuningan Tugu Ikan Intersection: from 1914.2 SMP/hour before the holidays to 2125 SMP/hour during.

Overall, there's an 11% increase in vehicle volume during the holiday season compared to normal days at this intersection. This aligns with Kuningan's tourism data, which shows an average 9.02% annual surge in tourists over the last three years.

This rise in tourist visits is a likely driver for the average 1.02% annual increase in overall vehicle numbers in Kuningan over the past five years. The correlation strongly suggests that increased tourism activity, especially during holidays, contributes to higher vehicle volumes at the Kuningan Tugu Ikan Intersection.

VISSIM PTV MODELING

From the results of the analysis using the PJKI 2023 method at the Three Tugu Ikan Intersection in Kuningan Regency, a DJ value of 0.776 was obtained and it was stated that the DJ value> 0.75 required an alternative solution to improve intersection performance. The use of PTV VISSIM software must be modeled when the intersection is in existing conditions in order to describe the situation at the research location. In Indonesia, driving behavior is calibrated to reflect the characteristics of Indonesian drivers.

Table 7. Driving Behavior for calibration.

Calibration to	Changed parameters	Changed components	Value	
			Vissim default	After Calibration
1	Model Following Car	Average Stopping Distance	2 m	0.6 m
2		Additive Part of Castor Safety	2 m	0.6 m
3		Multiplication Part of Safe Distance	3 m	1 m

4	Lateral	Desired Position at Free Flow	Middle of the Line	Anything
5		Standing Distance	1 m	0.4 m
6		Long Distance Driving	1 m	0.4 m

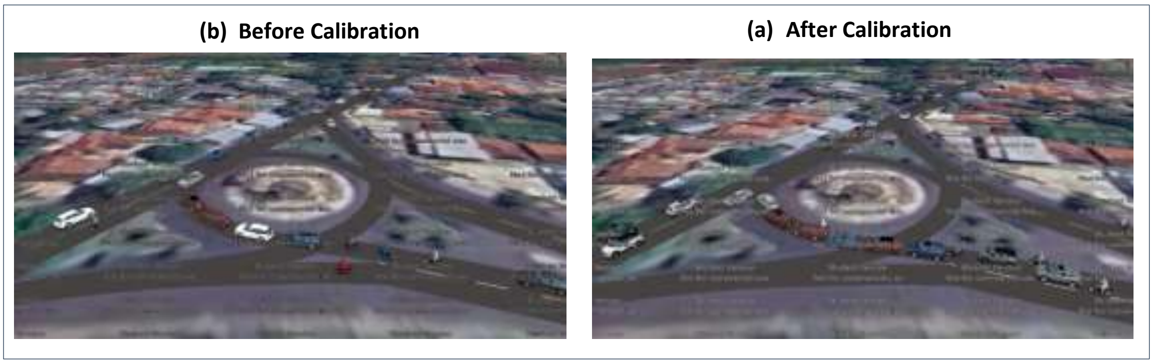

Fig. 7. VISSIM Simulation Results Before and After Calibration.

The GEH (Geoffery E. Havers) statistical test is a standard approach to comparing two sets of traffic volumes between summed and modeled data. The formula used is:

$$\mathbf{GEH = \sqrt{\frac{2(M-C)^2}{(M+C)}}}$$

Table 8. Evaluation Results between Existing Volume and VISSIM Volume After Calibration.

No.	Arms	Field Volume (Vehicles /hour)	Vissim Volume (Vehicles/hour)	GEH	Similarity Percentage (%)	Note
1	Raya Ciperna St.	1314	1243	1.986	95	OK.
2	Lkr. Sampora St.	673	633	1.565	94	OK.
3	Raya Cilimus St.	1024	949	2.388	93	OK.

Based on the data displayed, the difference is relatively small and still within the tolerance limit, namely the GEH value < 5, with a conformity rate of more than 90%.

PTV VISSIM MODELING RESULTS

Simulation results to evaluate traffic at three intersections without traffic signals include vehicle speed data, delay time, queue length, and level of service (LoS). After validation, it can be seen that the VISSIM modeling can be said to be valid so that an evaluation can be carried out to determine the performance of the Kuningan Regency Tugu Ikan Intersection. The following are the results of the VISSIM simulation:

Fig. 8. VISSIM Simulation Results.

Table 9. VISSIM Modeling Results for Volume, Speed, and Queue Length.

No.	Arms	Vissim Volume (Vehicles/hour)	Speed (km/h)	Tail Length (m)
1	Raya Ciperna St.	1243	22	0.000
2	Lkr. Sampora St.	633	28	18.960
3	Raya Cilimus St.	949	21	6.600
	Average		24	8.520

Table 10. Results from VISSIM Modeling of Delay and Service Levels

No.	Arms	Delay (Seconds)	Intersection Delay	Service Level
1	Ciperna Highway - Cilimus Highway	4.6	13.345	LoS B
2	Raya Ciperna - Lkr. Sampora St.	3.61		
3	Lkr. Sampora - Ciperna Highway	40.85		
4	Lkr. Sampora - Cilimus Highway	0.42		
5	Cilimus Highway - Ciperna Highway	12.6		
6	Raya Cilimus St - Lkr. Sampora St.	17.99		

In the PKJI 2023 analysis results, the peak hour LoS is included in category D where category D approaches unstable flow and low speed, the difference is due to the parameters used in PTV VISSIM using the delay value while in PKJI 2023 using DJ where this is also regulated in the Minister of Transportation Regulation No. KM 96 Year 2015: KM 96 Year 2015.

Traffic performance conditions at the Tugu Ikan Three Intersection in the next 5 to 10 years are not expected to be the same as current conditions, given the growth in the number of vehicles and changes in community mobility patterns. Therefore, to predict and evaluate the performance of the intersection in the future, a simulation is carried out using VISSIM software based on data from the analysis of traffic volume projections and intersection performance parameters for the next 5 to 10 years. The following are the VISSIM simulation results for the next 10 years:

Fig. 9. Results of Junction Performance Projections for the Next 10 Years

Table 11. VISSIM Modeling Results for Volume, Speed, and Queue Length in the Next 10 Years

No.	Arms	Vissim Volume (Vehicles/hour)	Speed (km/h)	Tail Length (m)
1	Raya Ciperna St.	1699	20	0.870
2	Lkr. Sampora St.	901	12	72.540
3	Raya Cilimus St.	1298	18	26.150
	Average		17	33.187

Table 12. VISSIM Delay and Service Level Modeling Results in the Next 10 Years

No.	Arms	Delay (Seconds)	Intersection Delay	Service Level
1	Ciperna Highway - Cilimus Highway	5.03		
2	Raya Ciperna St - Lkr. Sampora St.	4.54		
3	Lkr. Sampora - Ciperna Highway	111.3	31.698	LoS D
4	Lkr. Sampora - Cilimus Highway	35.14		
5	Cilimus Highway - Ciperna Highway	12.92		

6	Raya Cilimus St - Lkr. Sampora St.	21.26

This supports that for the next 10 years the intersection will experience a decrease in intersection performance. If it is not immediately repaired, it will experience traffic spikes that can cause congestion that can disrupt activities in the Kuningan Regency area, so it is necessary to make traffic engineering efforts at the intersection. Alternative recommendations that will be applied to the Kuningan Regency Tugu Ikan Intersection are as follows.

Traffic Engineering Lane Diversion Based on Percentage of Tourist Attractions (Alternative 1)

In Alternative Recommendation 1, Traffic Engineering Lane Diversion is applied by using Kuningan Regency Tourism data, where Tourism data is presented based on the number of intended tourist visitors based on the closest route to the tourist attraction. From this percentage, it is then applied to vehicle volume data both entering and exiting Kuningan Regency, then determining which route must be traveled based on the tourism data.

Traffic Engineering Lane Diversion (Alternative 2)

In this alternative, traffic engineering is applied to the Kuningan Three Tugu Ikan Intersection, where at the intersection a lane diversion is carried out from the main lane to the minor lane. Where the entire traffic flow from north to south (major) is diverted to the east (minor) where in the condition of the traffic field coming from the direction of Cirebon Regency or all traffic from the Ciperna Toll Road section towards Cilimus Road is diverted to the Kuningan Sampora East Ring Road.

Traffic Engineering Addition of Traffic Signal Devices at the Intersection (Alternative 3)

At the Three Tugu Ikan Kuningan Intersection has an intersection type of 322 and does not have an APILL, therefore the recommended alternative in this 3rd alternative, the intersection will be given an APILL (Traffic Signaling Device). The addition of this signal uses 2 phases with the following cycle times:

The green light distribution is as follows:

Table 13. Green Light Distribution

Phase 1	North - South (main)				
	55	3	2	48	2
Phase 2	East (minor)				
	58	2	45	3	2

Best Scenario (Alternative 2)

Table 14. VISSIM Modeling Results Volume, Speed, and Queue Length under Alternative 2 Best Scenario

		Alternative 2		
No.	Arms	Vissim Volume (Vehicles/hour)	Speed (km/h)	Queue Length (m)
1	Raya Ciperna St.	1698	19	1.520
2	Lkr. Sampora St.	901	33	0.530
3	Raya Cilimus St.	1277	16	47.200
	Average		22.679	16.417

Table 15. VISSIM Modeling Results Delays and Level of Service in the Best Alternative Scenario 2

		Alternative 2		
No.	Arms	Delay (Seconds)	Intersection Delay	Service Level
1	Ciperna Highway - Cilimus Highway	0	14.075	LoS B
2	Ciperna St - Sampora St.	6.01		
3	Lkr. Sampora - Ciperna Highway	11.1		
4	Lkr. Sampora - Cilimus Highway	0.66		
5	Cilimus Highway - Ciperna Highway	19.99		
6	Cilimus St - Lkr. Sampora St.	46.69		

CONCLUSIONS AND RECOMMENDATIONS

Observations at the Kuningan Three Tugu Ikan Intersection (unsignalized) reveal significant traffic challenges, particularly during holiday seasons.
Current and Projected Conditions:

- Normal Peak (Dec 14, 2024, 2-3 PM): Traffic Volume (Q Total) = 1913.2 smp/hour, Degree of Saturation (DJ) = 0.639, Delay (T) = 11.247 seconds/SMP, LOS B.
- Holiday Peak (Dec 28, 2024, 2-3 PM): Q Total = 2125 smp/hour, DJ = 0.776, Delay = 13.075 seconds/SMP, LOS B. This increase is largely driven by a 60.67% average surge in tourist visits to Kuningan Regency during December over the past three years.

- 5-Year Projection (2029): Q Total = 2523.608 smp/hour, DJ = 0.92, Delay = 16.213 seconds/SMP, LOS C.
- 10-Year Projection (2034): Q Total = 3016.456 smp/hour, DJ = 1.10, Delay = 25.234 seconds/SMP, LOS D. These projections indicate a severe decline in service level, exacerbating congestion.

Proposed Traffic Engineering Alternatives (via PTV VISSIM):

- Alternative 1 (Lane Diversion based on Tourism Routes): Average intersection speed = 18 Km/hour, Delay = 25.925 seconds, Queue Length = 32 meters, LOS D. This alternative significantly reduces queue length.
- Alternative 2 (Diversion of Cirebon/Ciperna traffic to Kuningan Sampora East Ring Road): Average intersection speed = 23 Km/hour, Delay = 14.075 seconds, Queue Length = 16.417 meters, LOS B. This alternative positively impacts intersection performance by significantly reducing both queue lengths and delays.
- Alternative 3 (APILL Installation): This option showed negative impacts, increasing queue length to 77.260 meters, causing delays of 36.347 seconds, reducing speed on Jl. Lingkar Sampora to 12 Km/hour, and resulting in LOS D.

Based on PTV VISSIM modeling, Alternative 2 is the recommended solution. This involves diverting all traffic from Jl. Raya Ciperna to turn left towards the Kuningan Sampora East Ring Road, effectively mitigating future congestion at the Kuningan Three Tugu Ikan Intersection.

ADVANCED RESEARCH

This research on three-way intersection traffic during holidays has limitations, suggesting key areas for future study:

1. Enhanced Model Validation: Future work needs more comprehensive, real-time field data (e.g., traffic volume, speed, queues across varied conditions) and remote sensing technologies for precise model calibration and validation.
2. Expanded Scenario Analysis: Explore a wider range of traffic engineering solutions, including optimizing traffic signal phasing and implementing Intelligent Transportation Systems (ITS).
3. Integrated Impact Assessment: Incorporate environmental (e.g., emissions, noise) and economic (e.g., operating costs, time losses) analyses to provide a holistic cost-benefit view of interventions.

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