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Engineering Management Analysis at Signalless Intersection 3, Tukad Yeh Aya Street–Pemuda Street Use PKJI 2014

Putu Ariawan[1], Putu Budiarnaya[2], I GNN Wismantara[3], dan I Made Mangku Rangin Wijaya[4]
[1,2,3,4] Civil Engineering Study Program, Universitas Pendidikan Nasional, Denpasar Bali

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ABSTRACT

Dense traffic on the roadway often causes traffic bottlenecks, particularly at intersections, such as the unsignalized junction of Tukad Yeh Aya Street and Pemuda Street. The study goals are three analyses: existing performance analysis, alternative selection, and forecast analysis. The study of the performance of the Tukad Yeh Aya Street – Pemuda Street junction in the current situation yields a value of C, which is represented by the duration of intersection delay, which is 24.53 seconds / cur. This result is 1,09 more than PKJI, 2014 limit of 0.85. As a result, various options must be implemented or planned in order to decrease the value of the degree of saturation to a specified limit. To enhance the performance of the Tukad Yeh Aya Street – Pemuda Street junction, two options were based on the current circumstances, designing a one-way and adding APILL lights for four stages led by 2014 PKJI. After calculating, the alternative finds that the one-way road planning alternative has an intersection delay of 10.06 second / cur or the service level is good with a value of B. Therefore, the one-way road planning alternative is chosen as the one that will be used in planning the next five years.

Corresponding Author:

Putu Ariawan,
Civil Engineering Study Program,
Universitas Pendidikan Nasional, Denpasar Bali.
Email: putubudiarnaya@undiknas.ac.id

1. INTRODUCTION

The growth in population and the increasing number of needs in the South Denpasar area resulted in the movement of people and goods becoming more rapid. This is directly proportional to the increase in the number of vehicle movements and this increase leads to increasingly complex traffic conflicts (Haryadi, 2018)

The conflicts referred to include the density of vehicles on the roads, crowds of vehicles in public places or places that sell people's needs and an increase in the number of vehicles (Kuncoro et al., 2019). One of the intersections in South Denpasar that needs improvement and capacity building is the three unsignalized intersection of Jalan Tukad Yeh Aya and Jalan Pemuda. Based on the data from the preliminary survey results that have been conducted, this intersection has a degree of saturation reaching 0.92 and is based on (Umum, 2014) the tolerable degree of saturation results does not exceed 0.85. Also obtained a lower limit queue opportunity of 33.61% and an upper limit queue opportunity of 66.30% and a delay of 16 det/skr. Therefore according to the table on Permenhub (KM 96 of 2015) the level of service at this intersection is C or Medium. The reason the performance of this intersection is less than optimal is because Jalan Pemuda is a road that leads to the main road, Puputan Highway. Tukad Yeh Aya Road is a road that connects Renon

Village and Panjer Village. Because traffic has to move quickly to that place, this intersection is a major point of conflict (Khisty & Lall, 2005). The formulation of the problem in this study is what is the state of the intersection in the existing conditions and what alternatives can be used to solve the problems found at the intersection. Based on the formulation of the problem previously mentioned, this study aims to find out the existing condition of the intersection and get the appropriate options to solve the problem at the intersection.

Indonesia Road Capacity Guidelines 2014

Based on PKJI, 2014 are guidelines for planning, designing, and operating adequate transportation facilities (Umum, 2014). The relationship between capacity and discharge values is used to plan, design and operate roads in Indonesia, as well as seek improvement MKJI, 1997 is expected to be a technical reference for road administrators, transportation operators, teachers and professionals to plan and evaluate urban roads and intersections at the central level and area of mouth capacity (Umum, 2014).

Signalless intersection

Is a type of intersection that is commonly found in urban areas(Mandasari & Riani, 2019). This type of intersection is suitable in situations where the volume of traffic on the road is small and the turning movements are small, but the state of the intersection to be studied does not have these characteristics.(Riyadi, 2020)

Capacity

$$C = C_0 \times F_{LP} \times F_M \times F_{UK} \times F_{HS} \times F_{BKi} \times F_{BKa} \times F_{RMi} \qquad (1)$$

Description :

C : Basic Capabilities
Co : Idiel Capability
F_{LP} : Aspect of arm width adjustment
F_M : Corrected aspect of median type
F_{UK} : Corrected aspect of city scale
F_{HS} : Side crimp corrected aspect
F_{BKI} : Aspects corrected flow in and out turn left
F_{BKA} : Aspects corrected flow in and out turn right
F_{RMi} : Corrected aspects of flow in and out of the minor line

Degree of Saturation

$$D_J = \frac{q}{C} \qquad (2)$$

Description :

q = Total flow of vehicles in and out of the intersection
F_{skr} = The skr factor can be obtained from the existing equation
C = Basic capabilities

Delay

Based on PKJI, 2014, delays consist of (T_{LL}) and (T_G). T_{LL} is a delay that occurs due to the interaction of several vehicles at the intersection. T_G is a delay that occurs due to a vehicle turning or stopping. To get the delay time, you can use the following formula

$$T = T_{LL} + T_G \qquad (3)$$

Description :

T_G = Geometric Delay
T_{LL} = Traffic delays

Queuing Opportunities (P_A)

Batas Atas peluang: $P_A = 47{,}71\, D_J - 24{,}68\, D_J^2 + 56{,}47\, D_J^3$ (4)
Batas Bawah peluang: $P_A = 9{,}02\, D_J + 20{,}66\, D_J^2 + 10{,}49\, D_J^3$ (5)

Description:

P_A = Queuing Probability
D_J = Degree of Saturation

Signalized Intersection

Based on PKJI, 2014, the performance of signalized intersections can be seen from the magnitude of the departure flow under ideal conditions (So), the magnitude of the departure flow during existing conditions (S), the ratio of incoming and outgoing flows to saturated in and out flows (R_Q/S), cycle period (c), green period (H), capability (C), degree of saturation (D_J).

Saturated Current

$$S = S_o \text{ x } F_{HS} \text{ x } F_{UK} \text{ x } F_G \text{ x } F_P \text{ x } F_{BKi} \text{ x } F_{BKa} \quad (6)$$

Description :

F_{HS} = Side crimp corrected aspect
F_{UK} = Corrected aspect of city scale
F_G = Corrected aspect due to tilt
F_P = Boundary corrected aspect
F_{BKi} = Aspect corrected S_o because the vehicle is turning left
F_{BKa} = Aspect corrected S_o because the vehicle is turning to the right

Basic Saturated Current

$$S_o = 600 \text{ x } L_E \quad (7)$$

Description :

S_o= Aliran ideal
L_E = Lebar lengan efisien

Current/Saturated Current Ratio (R_Q/S)

$$R_{Q/S} = \frac{Q}{S} \quad (8)$$

Description :

S = Aliran jemu (skr/jam)
Q = Volume kendaraan (skr/jam)

Waktu Siklus (c)

$$c = \frac{(1{,}5 \; x \; HH+5)}{1-\sum RQ/S \; kritis} \quad (9)$$

Description :

c = The total amount of time required
H_H = Green time is totally lost
$R_{Q/S}$ = The ratio of inlet and outflow (q) to saturated inflow (S) of an arm
$R_{Q/S \text{ kritis}}$ = $R_{Q/S}$ greatest in all phases
$\sum R_{Q/S \text{ kritis}}$ = Amount $R_{Q/S \text{ kritis}}$

Capacity

$$C = S \text{ x } \frac{H}{c} \quad (10)$$

Description :

C = Basic capabilities
S = tired flow
H = green period
c = The total amount of time required

Degree of Saturation

$$D_J = \frac{Q}{C} \quad (11)$$

Description :

D_J = Degree of Saturation
Q = vehicle volume
C = basic capabilities

Queue Length (P_A)

$N_Q = N_{Q1} + N_{Q2}$ (12)

Description :

N_{Q1} = Remaining amount of skr
N_{Q2} = The amount of skr that is in the red period

Vehicle Stopping Ratio (R_{KH})

$R_{KH} = 0{,}9 \times \frac{NQ}{Q \times c} \times 3600$ (13)

Description :

N_Q = Total vehicle waiting at the start of the green period
c = The total amount of time required
Q = the vehicle volume

Delay

$T_i = T_{Li} + T_{Gi}$ (14)

$T_{Li} = c \times \frac{0{,}5 \times (1-RH)^2}{(1-RH \times DJ)} + \frac{N_{Q1} \times 3600}{c}$ (15)

$T_{Gi} = (1 - R_{KH}) \times P_B \times 6 + (R_{KH} \times 4)$ (16)

Description :

P_B = Turning vehicle distribution
R_H = Comparison of the green period to the phase period of the arm under review

Single Way Path

Based on (Hobbs, 1995), planning a single-way road network system is an alternative that can be used to break congestion and shorten traffic delays. The planning of this single-way road network system is planned to reduce the number of incidents and maximize the capacity of the road.

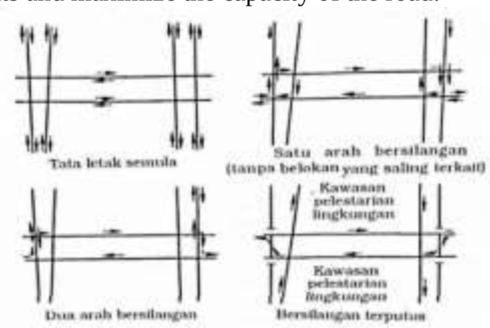

Figure 1. One-way street system (Source: Hobbs, 1995)

(*Level of Service*)

Based on Permenhub (KM 96 of 2015), service quality is the ability of a road or intersection to receive or collect vehicles in certain circumstances.

Table 1. Level of presentation

Level of Service	Condition	Average Stop Delay (det/skr)
A	Very Good	< 5
B	Good	5 - 15
C	Medium	12 - 25
D	Less	25 - 40
E	Bad	40 - 60
F	Very Bad	> 60

(Source: Permenhub KM 96, 2015)

2. RESEARCH METHOD

The research methodology was carried out according to the following stages:

1. Conduct a preliminary survey for 1 week or 7 days
2. Carry out the process of data collection and get primary data and secondary data
3. Primary data includes the type of vehicle, vehicle volume and intersection geometric. As well as secondary data in the form of location plans and population data obtained from the website of the Central Statistics Agency for the Province of Bali
4. After getting the data, then do the data recapitulation using analysis based on the 2014 PKJI
5. Then get the results of the performance analysis on the existing conditions
6. Existing results determine the need for planned alternatives
7. If the alternative calculation exceeds the set limit, then another alternative must be planned.
8. If the alternative meets the specified limits, then it can be followed up with performance predictions for the next 5 years
9. Provide conclusions on the performance analysis of the intersection with the alternative that has been planned

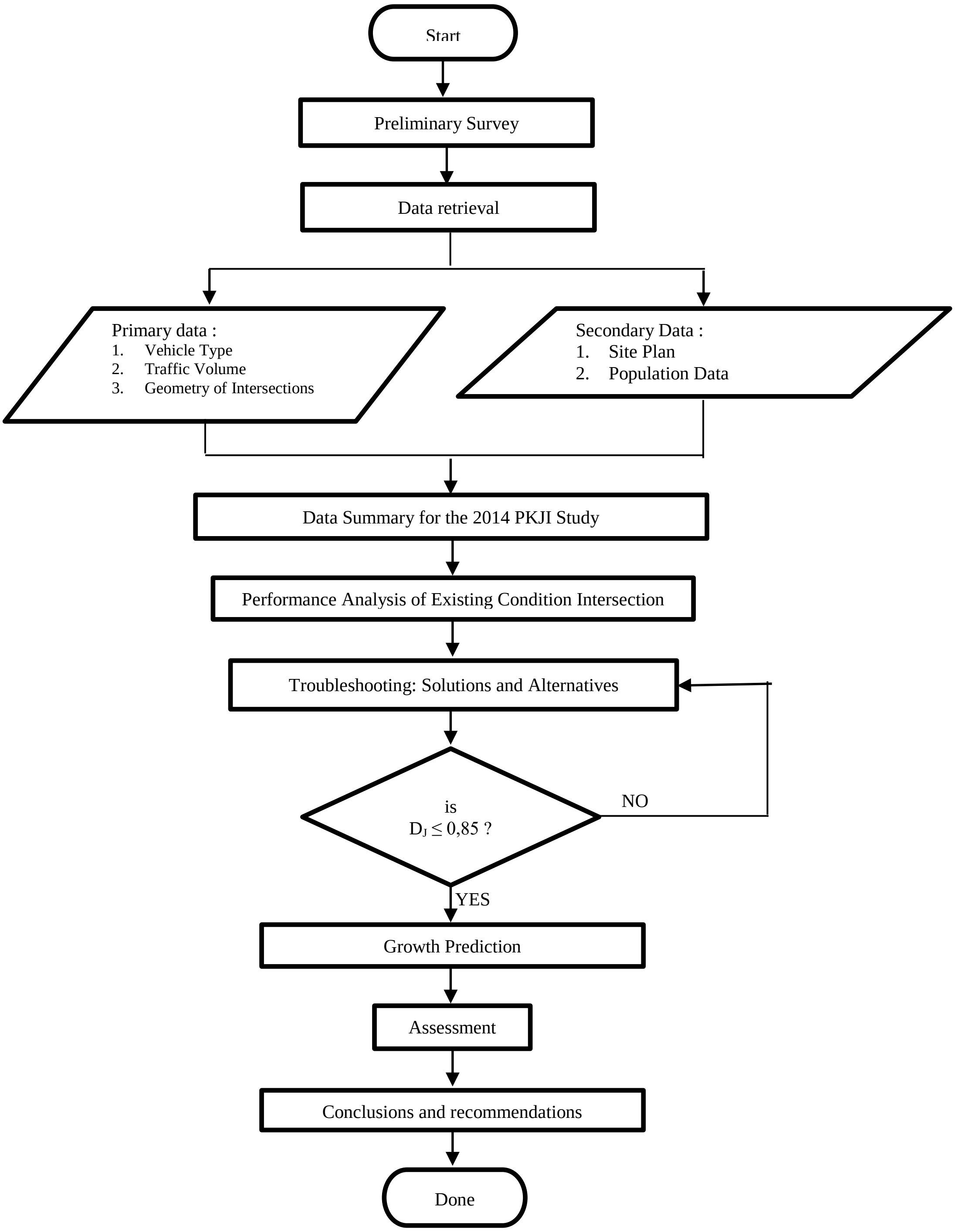

Figure 2. Research flowchart

3. RESULTS AND DISCUSSIONS

. Existing Conditions

The existing conditions were obtained based on the results of observations made in the field (Amtoro, 2016). As for the results of the observations made to obtain data on the geometric conditions of the road which are explained as follows

1. Data Geometry
   A. North (A) : Youth Street with a width of 6 meters
   B. East (B) : Tukad Yeh Aya Road with a width of 6 meters
   C. Western (C) : Tukad Yeh Aya Road with a width of 6 meters

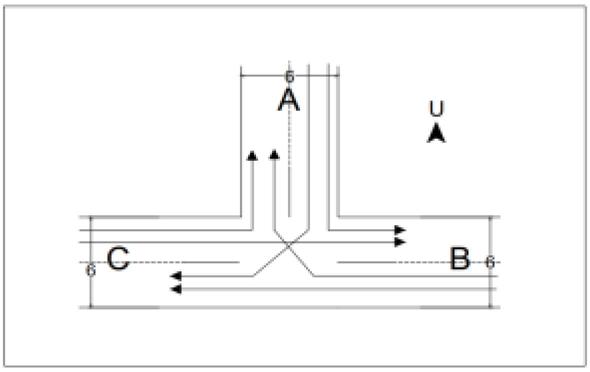

Figure 3. Geometric Conditions

2. Calculation of Traffic Volume

Traffic volume data obtained from the results of the review. The survey was carried out by recording the means of transportation using a mobile phone and recording directly for two hours with a 15-minute break during peak morning hours (06.30 – 08.30 WITA), noon (11.00 – 13.00 WITA), and evening (16.00 – 18.00 WITA). The survey was conducted on Monday (10 May 2021).

Table 2. Traffic volume data recapitulation

Periode of Time	**Minor**	**Mayor**		**Total (skr/jam)**
	Utara	**Timur**	**Barat**	
06.30 - 07.30	349	258	475	1082
07.30 - 08.30	537	364	679	1580
11.00 - 12.00	705	441	807	1953
12.00 - 13.00	773	521	850	2144
16.00 - 17.00	854	619	876	2349
17.00 - 18.00	886	670	904	**2460**

DISCUSSION

1. Performance Analysis on Existing Conditions

Table 3. Recapitulation of existing performance analysis results

Traffic Volumes (Q) (skr/jam)	Capacity (C) (skr/jam)	Degree of Saturation (DJ)	delay (T) (det/skr)	Queue Opportunity (PA)
2460	2251.7	1.09	24.53	48.17 - 96.26

2. Alternative I One Way Road Planning

Option I is planned for a single-turn road network that follows the rules of the 2014 PKJI. The road planned for this alternative is Jalan Pemuda from the North arm, as a result all vehicles aiming for the West and East arms must be diverted. On the North arm, all vehicles heading to the East arm are required to turn left onto Jalan Pemuda V, while those heading to the West arm are all vehicles required to turn right onto Jalan Telaga Waja.

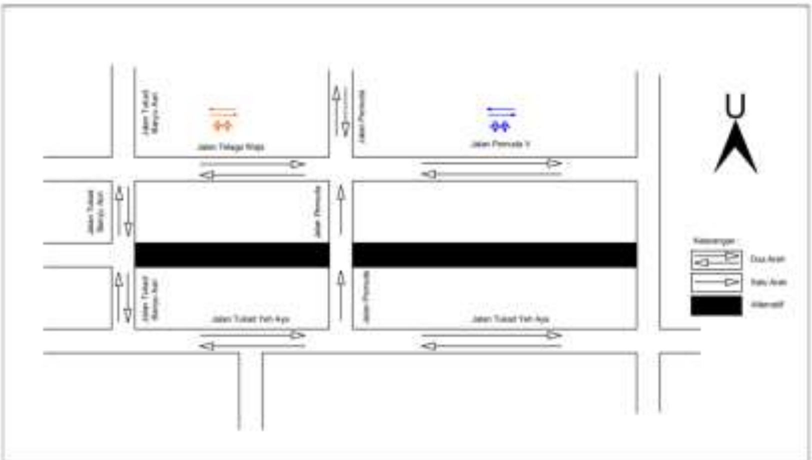

Figure 4. Circulation of vehicle flow diversion

Table 4. Summary of alternative one-way road planning results

Traffic Volume (Q) (skr / jam)	Capacity (C) (skr / jam)	Degree of Saturation (DJ)	Postponement (T) (det/skr)	Queuing Opportinities (PA)
1574	2994.6	0.53	10.06	11.95 - 26.42

3. Alternative II Installation of APILL Lamps
Option II is planned to install APILL lights by combining 2 adjacent intersections (Budiyanto, 2014), namely at the intersection on Tukad Yeh Aya Street and Pemuda Street and the intersection on Tukad Yeh Aya Street and Tukad Badung Street, which is guided by the 2014 PKJI.

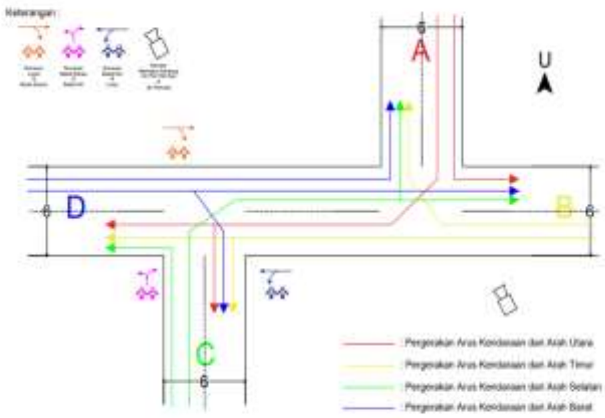

Figure 5. The geometric conditions of the alternative plan II

Table 5. Design guidelines for the deviation period

Arm	Time of Light on (seconds)				Cycle Time
	Red	Yellow	Green	*All Red*	
Western	139	3	20	7	162
Eastern	134	3	26	7	
Northern	123	3	36	8	
Southern	120	3	38	8	

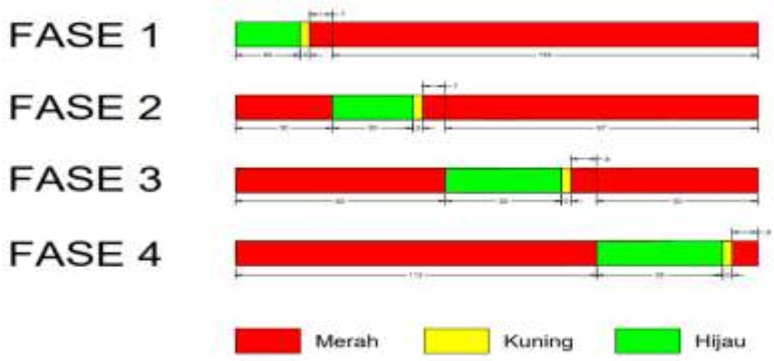

Figure 6. Cycle time planning diagram

Table 6. Recapitulation of planning results for installing APILL lights

Approach	Traffic Flow (Q) skr / jam	Capacity (C) skr / jam	Degree of Saturation (D_J)	N_Q skr/jam	P_A m	Delays det/skr
Utara	308	393	0.78	14.3	147	91.8
Timur	217	277	0.78	10.7	120	97.5
Selatan	309	394	0.78	14.3	147	90.4
Barat	176	225	0.78	8.9	93	100.8

In the application of the alternatives above, namely Alternative I and Alternative II which show the degree of saturation (DJ) and delay (T) the smallest and in accordance with the requirements is alternative I. Therefore alternative I was chosen for solving the problem at the unsignalized intersection of Jalan Tukad Yeh Aya – The Street of Youth.

4. CONCLUSION

Based on the results of previous calculations, several conclusions were obtained, among others:

1. Performance analysis of the intersection of Jalan Tukad Yeh Aya - Jalan Pemuda in real conditions in the field shows quite good or moderate results with a C value, this is indicated by the long delay of the intersection, which is 24.53 det/skr, as for other parameters that can show the performance of this intersection is the intersection capacity of 2251.7 skr/jam, traffic volume of 2460 skr/jam, and degree of saturation of 1.09 where this value exceeds the limit set by PKJI, 2014 which is less than 0.85. Therefore it is necessary to do or plan several alternatives to reduce the value of the degree of saturation to a predetermined limit, then with the value of the degree of saturation above, the probability of queuing for the upper limit is 96.26% and for the lower limit is 48.17%.
2. In order to improve the performance of the unsignalized intersection of Jalan Tukad Yeh Aya - Jalan Pemuda, 2 alternatives were made according to the conditions at the intersection of Jalan Tukad Yeh Aya - Jalan Pemuda, namely the planning of a one-way road network and the installation of APILL

lights for 4 phases based on PKJI 2014. After analysis, the results obtained from the two alternatives are as follows. In Alternative I planning, namely planning a one-way road guided by PKJI 2014 where planning is made at the intersection of Jalan Tukad Yeh Aya - Jalan Pemuda with an average capacity of 2994.6 skr/jam, the traffic volume is 1573 skr/jam, and the degree of saturation is 0.53 resulting in an intersection delay of 10.06 det/skr where this shows good results with service level B (Permenhub, 96 of 2015) and has the opportunity to queue for the limit for the upper limit of 26.42% and for the lower limit of 11.95%. In Alternative 2, the installation of APILL lamps for 4 phases results in a delay of 94.1 det/skr, with a long delay resulting in intersection conditions being considered very bad or with service level D (Permenhub, 96 of 2015). The other parameter used to assess the performance of alternative II is the degree of saturation of this alternative which is 0.78 and is still within the limits permitted in PKJI, 2014 namely (D_J <0.85), then the queue length for each approach is the The North (Youth Street) is 147m long, the East approach (Jalan Tukad Yeh Aya) is 120m, the South approach (Jalan Tukad Badung) is 147m and the West approach (Jalan Tukad Yeh Aya) is 93m. Based on the results obtained in the two planning alternatives above, Alternative I was chosen as the alternative to be implemented.

After the survey and calculation process was carried out according to the 2014 PKJI instructions at the unsignalized intersection of Jalan Tukad Yeh Aya - Jalan Pemuda, the researcher gave several suggestions for this study, namely as follows.

1. Utilize other existing references to analyze existing conditions or find alternatives needed to solve the problem.
2. The survey at the intersection of Jalan Tukad Yeh Aya - Jalan Pemuda is expected to be carried out with a more effective duration compared to the duration of the observations by the author.
3. It is hoped that surveys in the field will be carried out when climatic conditions are not good so that the weather is not fixated on sunny weather, so that the results of the research can be compared properly.
4. It is hoped that the next researcher can use related applications in order to be able to do engineering on each planned plan so as to get more credible results.
5. It is hoped that future researchers can examine the effects on roads and intersections that are passed by diverted vehicles.
6. This survey was conducted during the PPKM (Implementation of Restrictions on Community Activities) period due to the impact of the Covid-19 pandemic, therefore it is hoped that the next researcher can conduct a survey when the pandemic has ended.

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