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Study of the Potential Traffic Congestion in Intersection of Three the Sunset Road, Kerobokan Road, Seminyak Road-Badung, Bali

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Abstract

In this research, a method of traffic survey and analysis methods with regulations Indonesian Road Capacity Manual, from the calculation capacity values obtained on Monday morning at 2,422.681 (passenger car unit) pcu / hours, noon at 2,366.819 pcu / hour, an afternoon of 2,419.124 pcu / hour. Wednesday morning at 2,320.774 pcu / hour, noon at 2,490.786 pcu / hour and afternoon at 2,404.315 pcu / hour. Saturday morning at 2,535.207 pcu / hour, noon at 2,588.231 pcu / hour and afternoon at 2,463.082 pcu / hour. From the calculation of the degree of saturation (DS) and the intersection can determine the level of service. unknown degree of saturation on Monday morning at 1.114, noon at 1.220, afternoon at 1.230, on Wednesday morning at 1.173, noon at 1.200, afternoon at 1.230, on Saturday morning at 0.98, noon at 1,101, afternoon at 1,195. Delay junction (Delay) on Monday the morning obtained at 24.612 sec / pcu, noon at 41.672 sec / pcu, afternoon at 45.256 sec / pcu service levels average D and E, on Wednesday morning by 34.37 sec / pcu, noon at 39.98 sec /pcu, afternoon at 49.256 sec / pcu average service levels D and E, on Saturday morning at 18.15 sec / pcu, noon at 25.39 sec / pcu, afternoon at 38.79 sec / pcu, Services Tertiary average C and D.

Keywords---*capacity, degree of saturation, delay.*

I. Introduction

The development of Denpasar City as the capital of the City of Bali Province and the center of Balinese community activities in the fields of economy, education, trade, government and other activities . Thus, the need for increasingly dense transportation infrastructure causes frequent traffic jams on the road sections [2]. As is the case at the intersection of three the Sunset Road, Kerobokan Road, Seminyak Road, Badung is one of the roads that has a level of traffic congestion.

To determine the effectiveness of the vehicle lanes located along the intersection of three, it is very important and necessary to survey a passing vehicle to analyze the level of vehicle density on the lane.

Problems

From the background description above, the problem can be described as follows:

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1.How is the performance condition in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road in terms of volume and capacity?

2.What is the level of traffic congestion in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road?

3.What is the solution to reduce or overcome congestion in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road?

Research Aims

1.To find out the performance in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road when compared to volume and capacity.

2.To find out traffic jams in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road.

3.To find out the solution to reduce or overcome congestion in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road.

Research Benefit

1.To get smooth, order and comfort of traffic.

2.For the government, can provide smooth traffic flow services in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road.

II. Literature Review

Definition of Survey

The data collected consists of primary data and secondary data. Primary data collection is done by field survey, while secondary data is obtained from the authorized institutions in determining transportation policies such as the Department of Transportation and Regional Government. [1]

Definition of Intersections

Intersection is an area where two or more roads meet, join, intersect or cross. Intersections can also be referred to as a meeting between two or more roads, both on a plot or not on a plot or road network point where the roads meet and cross roads intersect [5]

Intersection Geometric Data

Various roads will show different performance on the loading of certain traffic, for example the road is divided and the road is not divided. Traffic lane width, load current speed and capacity increase with increasing traffic lane width. Geometric data intersection is done by recording the number of lanes and directions, determine the approach code (west, east and south) and the type of approach, the presence or absence of the road, measure the width of the approach, width of the path, width of shoulder and the median of the road (if any), the width of the approach in and out of the approach. As for the geometric data needed for the calculation of traffic performance (road capacity) include: road length (m), road width (m), road curb width (m), road type, number of lanes.[6]

The Coefficient of Passenger Car Units (PCU)

The number of these vehicles is grouped according to each type of vehicle, namely light vehicles (LV), heavy vehicles (HV), motorcycles (MC) and non-motorized vehicles (UM) unit value of passenger cars as follows [3] :

Table 1. Passenger Car Unit (PCU)

Number	**Transportation type**	**lass**	**Passenger Car Unit**	
			Segment	**Intersection**
1	Car/Jeep, Microbus/Pickup	V	1.00	1.00
2	Standard bus, Medium/heavy Truck	V	1.20	1.30
3	Motorcycle	C	0.25	0.40
4	Becak, Bike, Andong	M	0.80	1.00

Unsigned Intersection Capacity

According to the Indonesian Road Capacity Manual 1997, calculated from the following formula:

$C = C_0 \times F_W \times F_M \times F_{CS} \times F_{RSU} \times F_{LT} \times F_{RT} \times F_{MI}$ ……(1)

Where :

C_0 = Basic Capacity

F_W = Entry Width Adjustment Factor

F_M = The Main Road Median Compilation Factor

F_{CS} = Factor in City Size Compilation

F_{RSU} = Factors in the type of road environment, side barriers and non-motorized vehicles

F_{LT} = Deployment factor% Turn left

F_{RT} = Deployment factor% Turn right

F_{MI} = The factor of making a minor road current ratio

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Degre of Saturation

What is meant by the degree of saturation is the result of the flow of traffic to capacity is usually calculated hourly. The degree of saturation is calculated using the following formula:

$$DS = Q_{TOT} / C \quad \text{.....(2)}$$

Where:

DS = Degre of Saturation

Q_{TOT} = Total traffic flow volume at the intersection (pcu/ hour)

C = Capacity (pcu/ hour)

Average Delay

Average delay is the average waiting time of each vehicle entering the approach.

1. Determination of minor road traffic delays (DT_{MI})

$$DTMI = (QTOT \times DTI - QMA \times DTMA) / QMI \quad \text{.....(3)}$$

Where:

D_{TMI} = Delay for minor roads.

DT_{MA} = Delay for major roads.

Q_{TOT} = Total traffic flow volume at the intersection (pcu/ hour)

Q_{MA} = The volume of traffic flow on major roads.

Q_{MI} = Traffic volume on minor roads.

2. Intersection geometric delays (DG)

For DS < 1, 0 ;

$$DG = (1\text{-}DS) \times (P_T \times 6 + (1\text{-}P_T) \times 3) + DS \times 4 \text{ (sec/ pcu)} \quad \text{.....(4)}$$

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For DS≥1,0 : DG = 4.

Where :

DG = Intersection geometric delays.

DS = Degree of saturation.

P_T = Total turn ratio.

3. Delay junction (D)

The intersection delay is calculated as follows:

D = DG + DTi (sec/pcu)……(5)

Where :

DG = Intersection geometric delays.

DTi = Intersection traffic delays.

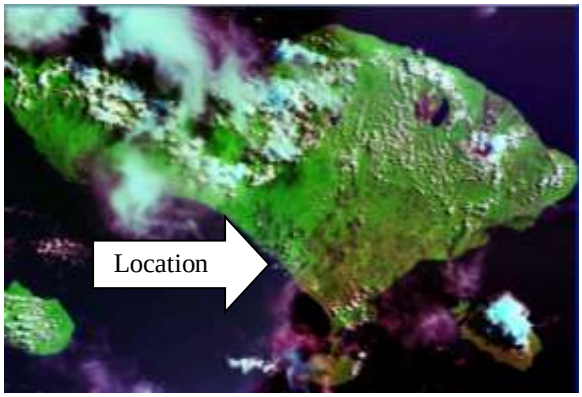
Queue Opportunities

The queuing opportunity is expressed in the range of values obtained from the relationship curve between queuing opportunity (QP%) and saturation degree (DS), which is queuing opportunity with more than two vehicles in any approach area, at unsignalized intersections [4].

III. Research Method

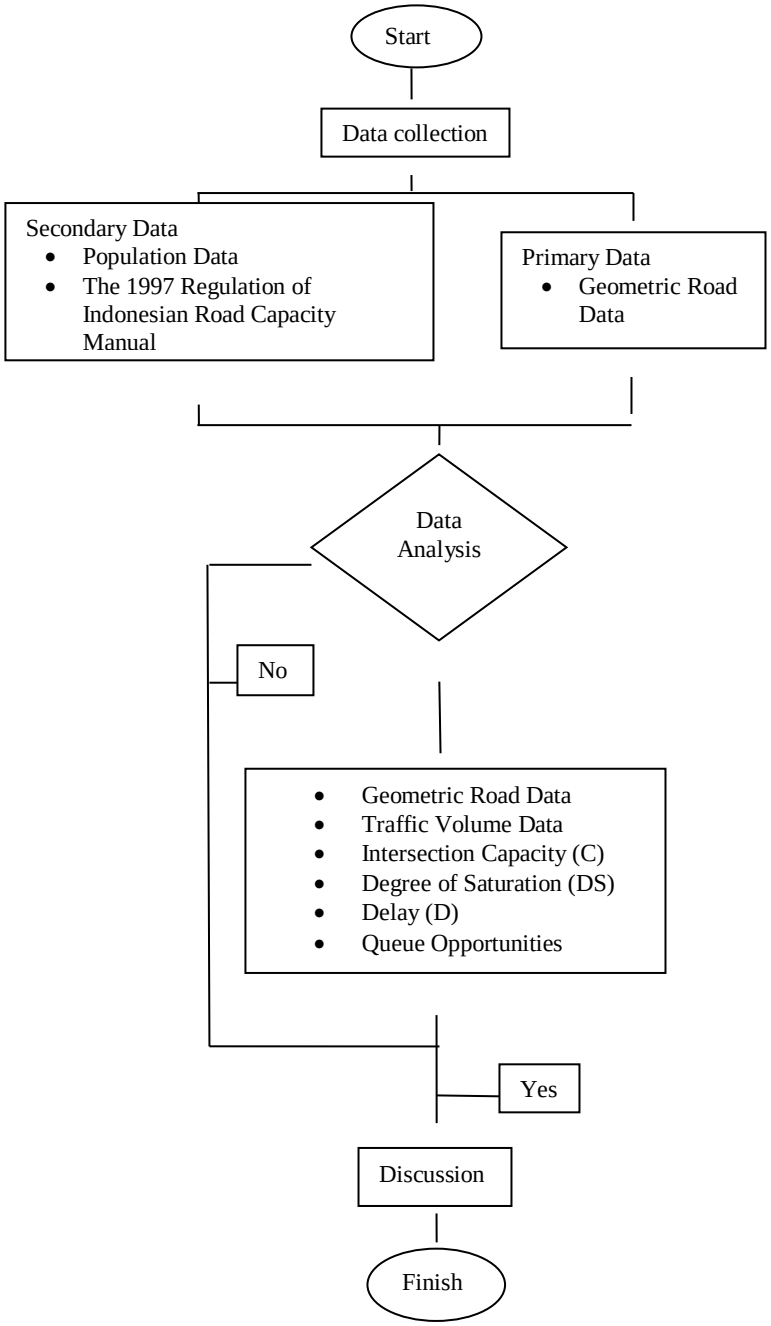
Locations

This research has been done in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road, Badung Regency, Province of Bali, Indonesia



Picture 1. Location of the research

Flow chart of the Research



Picture 2. Flowchart of the research

IV. Results and Discussion

Exsisting

The unsignalized intersection of three the Sunset Road, Kerobokan Road, Seminyak Road will be calculated using the Indonesian Road Capacity Manual program. Calculated as follows:

1.Capacity Calculation

Table 2. Results of Exsisting Capacity Calculation

Day	Peak Hour	Basic Capacity (C)	Average Approach width (FW)	Main Road Terrain (FM)	City Size (FCS)	Side Barriers (FRSU)	Turn Left (FLT)	Turn Right (FRT)	Minor Rasio/ Total (FMI)	Capacity (C) Pcu/hour
Monday	Morning	3,200	0.901	1.05	0.94	0.94	1.194	0.933	0.813	2,422.681
	Noon	3,200	0.901	1.05	0.94	0.94	1.203	0.905	0.808	2,366.819
	Afternoon	3,200	0.901	1.05	0.94	0.94	1.210	0.925	0.808	2,419.124
Wednesday	Morning	3,200	0.901	1.05	0.94	0.94	1.156	0.922	0.814	2,320.774
	Noon	3,200	0.901	1.05	0.94	0.94	1.247	0.923	0.809	2,490.786
	Afternoon	3,200	0.901	1.05	0.94	0.94	1.203	0.919	0.813	2,404.315
Saturday	Morning	3,200	0.901	1.05	0.94	0.94	1.269	0.942	0.814	2,535.207
	Noon	3,200	0.901	1.05	0.94	0.94	1.204	0.939	0.812	2,588.231
	Afternoon	3,200	0.901	1.05	0.94	0.94	1.219	0.943	0.811	2,463.082

- $F_W = 0{,}62 + 0{,}0646 \times W_I$

$W_I = (a/2 + b/2 + c)/\text{number of arms}$

- $F_{LT} = 0{,}84 + 1{,}61 \times P_{LT}$; $P_{LT} = Q_{LT}/Q_V$
- $F_{RT} = 1{,}09 - 0{,}922 \times P_{RT}$; $P_{RT} = Q_{RT}/Q_V$
- $F_{MI} = -0{,}555 \times P_{MI}^2 + 0{,}555 \times P_{MI} + 0{,}69$;

$P_{MI} = (A + B)/(A + B + C)$

2.Calculation of Traffic Behavior

Table 3. Results of Exsisting Traffic Behavior Calculation

Day	Peak Hour	DS	DT Sec/pcu	DMA Sec/pcu	DMI Sec/pcu	DG	D Sec/pcu	QP%

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Monday	Morning	1.114	22.612	14.802	26.508	4	24.612	100.65-47.89
	Noon	1.220	41.677	23.289	34.360	4	45.672	124.08-61.64
	Afternoon	1.230	45.256	24.604	54.538	4	49.256	126.50-62.739
Wednesday	Morning	1.173	30.370	18.590	36.380	4	34.370	113.22-56.69
	Noon	1.200	35.980	21.040	42.710	4	39.980	119.36-59.52
	Afternoon	1.230	45.256	24.604	37.181	4	49.256	126.501-55.83
Saturday	Morning	0.980	14.150	9.970	16.250	4.02	18.150	76.26-38.99
	Noon	1.101	21.390	14.150	24.860	4	25.390	98.04-49.60
	Afternoon	1.195	34.790	20.538	41.630	4	38.790	118.21-58.97

- DS = Qtot/C
- DT_I = 1,0504/(0,2724 – 0,2024 x DS)-(1-DS)x2
- D_{MA} = 1,05034/(0,346–0,246 x DS)-(1-DS)x1,8
- D_{MI} = (Qtot x DT – Q_{MA} x D_{MA})/Q_{MI}
- DG = (1-DS)x(P_Tx6 + (1-P_T)x3)+DSx4 ; for DS < 1,0 : for DS > 1,0: DG = 4
- D = DG + DT_I

Opportunity of the Upper Queue

- QP% = 47,77 x DS – 24,68 x DS^2 + 56,47 x DS^3

Lower Queue Opportunities

- QP% = 9,02 x DS + 20,66 x DS^2 + 10,49 x DS^3

The solution

In accordance with the results of the calculations above on Monday (morning, noon, afternoon), Wednesday (morning, noon, afternoon), Saturday (morning, noon, afternoon) has a level of service conditions C, D and E then for solutions to problems that arise in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road namely widening of the road on the Kerobokan Road, Seminyak Road and restrictions on heavy vehicles (HV) leading to the intersection of three the Sunset Road, Kerobokan Road, SeminyakRoad as follows:

1.Capacity Calculation

Table 4. Results of Calculation of Capacity that has been engineered

Day	Peak Hour	Basic Capacity (C)	Average Approach width (FW)	Main Road Terrain (FM)	City Size (FCS)	Side Barriers (FRSU)	Turn Left (FLT)	Turn Right (FRT)	Minor Rasio/ Total (FMI)	Capacity (C) Pcu/hour
Monday	Morning	3,300	0.980	1.05	0.94	0.94	1.197	0.932	0.813	2,638.89
	Noon	3,300	0.980	1.05	0.94	0.94	1.207	0.903	0.809	2,565.45
	Afternoon	3,300	0.980	1.05	0.94	0.94	1.216	0.924	0.809	2,644.69
Wednesday	Morning	3,300	0.980	1.05	0.94	0.94	1.157	0.930	0.814	2,520.96
	Noon	3,300	0.980	1.05	0.94	0.94	1.251	0.922	0.809	2,714.92
	Afternoon	3,300	0.980	1.05	0.94	0.94	1.272	0.924	0.812	2,776.75
Saturday	Morning	3,300	0.980	1.05	0.94	0.94	1.240	0.941	0.813	2,760.08
	Noon	3,300	0.980	1.05	0.94	0.94	1.273	0.939	0.811	2,830.56
	Afternoon	3,300	0.980	1.05	0.94	0.94	1.206	0.943	0.812	2,686.80

- $F_W = 0{,}62 + 0{,}0646 \times W_I$

$W_I = (a/2 + b/2 + c)/\text{number of arms}$

- $F_{LT} = 0{,}84 + 1{,}61 \times P_{LT}$; $P_{LT} = Q_{LT}/Q_V$
- $F_{RT} = 1{,}09 - 0{,}922 \times P_{RT}$; $P_{RT} = Q_{RT}/Q_V$
- $F_{MI} = -0{,}555 \times P_{MI}^2 + 0{,}555 \times P_{MI} + 0{,}69$;

$P_{MI} = (A + B)/(A + B + C)$

2.Calculation of Traffic Behavior

Table 5. Calculation Results of engineered traffic lau behavior

Day	Peak Hour	DS	DT Sec/pcu	DMA Sec/pcu	DMI Sec/pcu	DG	D Sec/pcu	QP%
	Morning	1.020	15.96	11.08	18.38	4	19.96	82.97-41.83

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Monday	Noon	1.120	23.22	15.12	26.91	4	27.22	101.88-50.76
	Afternoon	1.120	23.22	15.12	26.84	4	27.22	101.88-50.76
Wednesday	Morning	1.070	18.36	11.66	21.76	4	22.36	91.97-46.73
	Noon	1.090	19.78	11.48	23.51	4	23.78	95.81-48.57
	Afternoon	1.060	17.72	11.75	20.63	4	21.72	90.09-45.83
Saturday	Morning	0.890	10.94	13.67	9.59	4.12	15.06	62.72-32.12
	Noon	1.000	14.63	12.34	15.72	4	18.63	79.5-40.64
	Afternoon	1.090	19.78	11.48	23.76	4	23.78	95.81-48.57

- DS = Qtot/C
- DT_I = 1,0504/(0,2724 – 0,2024 x DS)-(1-DS)x2
- D_{MA} = 1,05034/(0,346–0,246 x DS)-(1-DS)x1,8
- D_{MI} = (Qtot x DT – Q_{MA} x D_{MA})/Q_{MI}
- DG = (1-DS)x(P_Tx6 + (1-P_T)x3)+DSx4 ; for DS < 1,0 : for DS > 1,0: DG = 4
- D = DG + DT_I

Opportunity of the Upper Queue

- QP% = 47,77 x DS – 24,68 x DS^2 + 56,47 x DS^3

Lower Queue Opportunities

- QP% = 9,02 x DS + 20,66 x DS^2 + 10,49 x DS^3

V. Conclusions and Suggestions

Conclusions

1. Results of Exsisting Calculation of Intersection Performance

Day	**Peak Hour**	**Capacity (C) Pcu/hour**	**DS**	**Delay Pcu/hour**	**Service Level**
Monday	Morning	2,422.681	1.114	24.612	D
	Noon	2,366.819	1.220	41.672	E

	Afternoon	2,419.124	1.230	45.256	E
Wednesday	Morning	2,320.774	1.173	34.370	D
	Noon	2,490.786	1.200	39.980	D
	Afternoon	2,404.315	1.230	49.256	E
Saturday	Morning	2,535.207	0.980	18.150	C
	Noon	2,588.231	1.101	25.390	D
	Afternoon	2,463.082	1.195	38.790	D

From the summary of the crossing performance calculation above, it can be seen that the service at the intersection of three the Sunset Road, Kerobokan Road, Seminyak Road when viewed from the delay, namely: on Monday, morning the service level is obtained D, noon and afternoon the service level is obtained E, on Wednesday, morning, noon and afternoon service levels obtained E, on Saturday morning service levels obtained C, noon and afternoon service levels obtained D.

2. Results of Calculation of Performance Solutions for Intersections

Day	**Peak Hour**	**Capacity (C) Pcu/hour**	**DS**	**Delay Pcu/hour**	**Service Level**
Monday	Morning	2,638.89	1.020	19.960	D
	Noon	2,565.45	1.120	27.220	E
	Afternoon	2,644.69	1.120	27.220	E
Wednesday	Morning	2,520.96	1.070	22.360	D
	Noon	2,714.92	1.090	23.780	D
	Afternoon	2,776.75	1.060	21.720	E
Saturday	Morning	2,760.08	0.890	15.060	C
	Noon	2,820.56	1.000	18.630	D

	Afternoon	2,686.80	1.090	23.780	D

From the summary of the crossing performance calculation above it can be seen the level of service at the intersection of three the Sunset Road, Kerobokan Road, Seminyak Road when viewed from the delay namely: on Monday morning the service level is obtained C, noon and afternoon the service level is obtained D, on Wednesday, morning, noon and afternoon service level D is obtained, on Saturday morning, noon and afternoon service level C.

Suggestions

1.Due to the rush hour traffic can not be diverted to other lanes, the road is widened on the Kerobokan Road, Seminyak Road and restrictions on heavy vehicles (HV) to in intersection of three the Sunset Road, Kerobokan Road, Seminyak Road.

2.The author hopes this research is useful and if it can be deepened the author suggests that when conducting a survey must be conducted in accordance with the specified time to obtain valid data.

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