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The Characteristic of Parking in *Pasar Badung* Area

I Ketut Sutapa [a]

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Abstract

In urban areas, the parking area was a problem that was quite complicated, especially in areas that become activities like industry centers, economy, tourism, and others. In term of this, it was due to the fairly large urbanization which causes an increasing population in urban areas. In addition, the level of private vehicle ownership was high enough so that it would directly add to the traffic flow. The problem that arose then was the traffic congestion caused by traffic flow exceeds the road capacity, the traffic processing system that is not good, nor because the road does not operate as it should. The one implication was the road not functioning properly was the parking of vehicles using the road (*on-street parking*). Therefore, this study was conducted to determine the park characteristics, in order to know the parking spaces capacity, as well as providing alternative solutions when capacity did not meet the parking space. This study was only conducted on the parking lot of the capacity market delinquent parking spaces as well as the park characteristics that included the accumulated parking, parking volume, parking average length, parking turnover rate, index parking of which was the object of this research was cars passenger and two-wheelers. In regarding this research could be used as input and consideration in determining or take wisdom in dealing with the parking problem in Pasar Badung (traditional market).

Author correspondence:
I Ketut Sutapa,
The Studies Program of Civil Engineering, Bali State Polytechnic
Bukit Jimbaran, P.O. Box 1064 Tuban Badung, Bali-Indonesia
Phone : +62-361-701981, Fax : +62-361-701128
Email address: iketutsutapa76@yahoo.com

1. Introduction

The parking facility is a component of a transportation system in which understanding is simply parking space to accommodate the vehicle when not in use. As we all knowing that motor vehicle in a traffic does not always move on. When traveling to one destination the vehicles were parked user performs an activity, whether it's business

[a] The Studies Program of Civil Engineering, Bali State Polytechnic, Bali, Indonesia

activities, recreation, school, and other activities; and sometimes even parking the vehicle in an amount greater than the number of vehicles in motion. The failure in providing adequate parking facilities can cause bottlenecks, frustration, even could reduce the access value of the building. It is to show that the park plays an important role in the transportation system.

In referring to the current economy and trade in the city is increasing at Denpasar creates a solid activity which led to an increasing volume of vehicles passing through the existing road. As an economy center and trade of Denpasar city need to provide adequate parking area, therefore, the traffic flow is not disrupted. One of them in the Badung market on Jalan Gajah Mada and Jalan Sulawesi, which are caused by the area of the parking lot owned Badung market is very narrow and irregular parked vehicles. Therefore, the driver/rider their vehicle parked outside the courtyard or the roadside, resulting in the road becomes narrower. Thus, the problem that arises is irregular parking which resulted in the parking spaces capacity to be reduced, the traffic problem congestion caused by vehicles are not balanced by the existing parking areas number, as well as irregular outgoing and incoming parking lot vehicle.

2. Materials and Methods

The research studies were taken in the parking lot location of Pasar Badung. The locations are drawn based on direct observation due to these locations, unlike very solid service level parking. The parking query lots and highways that exist around the traffic location flow is high enough that the market north side is on Jalan Gajah Mada and the market east side is on Jalan Sulawesi. Wherein, in order to park in Pasar Badung space, is already limited by shops and street vendors.

The survey was conducted within two days, the most crowded visitors, and regular day. It was expected during the days of the obtained day and peak hour parking as well as the variations that occur in there. The survey was started from 7 am to 3 pm, local time (8 hours). The time was taken considering Pasar Badung activity largely begins at 7 pm, while the market activity ended at 3 pm. Thus, the vehicles parked before 7 am and 3 pm were considerably less than between the hours from 7 am to 3 pm. The methods used in data collection was to conduct direct surveys (primary data) and note taking any necessary data and conduct data office in the research location (secondary data).

In order to obtain primary data was to find and get the direct data into the field to conduct research on parking. Pasar Badung parking lots survey was conducted by calculation in the boundary of the study area (*survey cordon count*) and as well as conducted a survey of parking capacity, that involves a parking swath and parking arrangements (*corner and parking plot large*). The algebraic summation of all vehicles that enter and exit an accumulated throughout the vehicle in the parking area. This accumulation shown the number of vehicles parked and running on in the area, this is a measure to the number of required parking facilities.

The data of parking provision spaces in research location based on existing. In order to know the spacious parking area is available now conducted on manual measurement by the surveyors, a number are needed two people, using the meter and stationery/form. The purpose of this survey is to know out on how many parking slots available and to determine the order specified in the study area. In order to obtain the number of normal capacity at the research location, was conducted by counting the number of parking slots used and the existing parking plot large. Informing on how terraced park's existing parking spaces on the margins, therefore, the data can be drawn from existing parking plan. The area that does not have a parking plot markers, the number of normal capacity or the number of parking slots are searched in the parking plot large that have been described previously.

In order to obtain the reliable data was done by direct visits and interviews to the officers on research location. The data was searched on this survey were: events duration/ parking activities in Pasar Badung every day. These data were obtained through the information that provided by the officers/employees authorized there.
Based on the survey results by note taking method, as follows:

1) Number of incoming vehicles (police number, time)
2) Number of vehicles exit (police number, time)
3) Number of parking plots
4) Order the parking lot (corner and large)

The data is intended to determine the amount/volume of vehicles parked and the parking accumulation at the location. Wherein, the process is done based on previous survey. For the accumulation calculation of parking used to the time interval at 60 minutes (*one hour*) during the research, therefore, it can be seen hourly accumulated parking

as well as known the volume hourly parking which indicates the fluctuation vehicles parked during the research period.

1) Number of intervals (x) → sorted from the interval have 1,2,3 ...etc.
2) Number of vehicles during x interval (Nx)
3) Total number of vehicles of each interval (Nt = Σ Nx)
4) The average parking duration:

$$\text{Pattern : } D = \frac{\Sigma\,(Nx)\,(X)\,(I)}{Nt}$$

Description :

D	=	average parking duration (hours/vehicle)
Nx	=	number of vehicles parked during the X interval
X	=	interval number
Nt	=	vehicles total number during the research
I	=	parking interval duration → using intervals at 15 minutes (0,25 hours)

Before calculating the parking average duration, it is better to find out the parking a vehicle duration, the data processor at aiming to determine each vehicle duration therein parking area. Therefore, the data can be searched parking duration average of each vehicle parking. For the average duration calculation of parking use at 15 minutes interval. The vehicle in an every parked merely 15 minutes is considered full when the double meaning full 30 minutes and so on. The inaccuracies may occur due to vehicles parked one minute or 14 minutes would be considered 15 minutes, however, it does not detract from the main objective wanted. The analysis was made by processing the data in the Pasar Badung as several variables on a variety may be performed to obtain a solution to parking problems that occur at the research location.

3. Results and Discussions

3.1 Volume parking

A parking volume is a number of vehicles parked in one place for a specific time. In term of this, the calculations are grouped every 15 minutes, therefore; can later be referred to fluctuations in the vehicle's parking every hour in the research location.

Table 1
The volume of vehicle parking in Pasar Badung *(off street parking)*

Day / Date	Vehicles Type	Vehicles number for 8 hours observations	Average vehicle/hour number
Wednesday,	Four-wheels	1022	128
19-01-2005	Two-wheels	3392	424
Sunday,	Four-wheels	1137	143
23-01-2005	Two-wheels	3672	459
Average four-wheels vehicle			135,5
Average two-wheels vehicle			441,5

Source: Survey result, in 2005.

Table 1 shows that the volume of two-wheels parked highest on Sunday, 23-01-2005 8:30 am to 08:45 am about 189 vehicles and the highest volume of four-wheels occur on Sunday, 23-01-2005 08:30 am to 08:45 am about 58 vehicles.

Table 2
The volume of Vehicle Parking on Jalan Sulawesi (*On Street Parking*)

Day / Date	Vehicles Type	Vehicles number for 8 hours observations	Average vehicle/hour number
Wednesday,	Four-wheels	26	4
19-01-2005	Two-wheels	415	52
Sunday,	Four-wheels	36	5
23-01-2005	Two-wheels	806	101
Average four-wheels vehicle			4,5
Average two-wheels vehicle			76,5

Source: Survey result, in 2005.

The table 2 shows the volume of two-wheels parked is the highest on Sunday, 23-01-2005 09:15 am to 09:30 am about 30 vehicles and the volume of a four-wheel vehicle parked the highest on Sunday, 23-01-2005 3 vehicles at 07:30 am to 07:45 am.

3.2 Parking Accumulation

The parking accumulation needs to be calculated determines how fluctuations parking at certain hours of the top use of the parking area, therefore, it can be measured parking space in the research location.

Table 3
The Accumulation of parking at the Pasar Badung area (*Off Street Parking*)

Day/Date	Vehicles type	Vehicles number	The highest accumulation time	The highest accumulation
Wednesday,	Four-wheels	1022	08.45 - 09.00	194
19-01-2005	Two-wheels	3392	10.00 - 10.15	1123
Sunday,	Four-wheels	1137	09.15 - 09.30	222
23-01-2005	Two-wheels	3672	09.00 - 09.15	1365
Average four-wheels vehicle				208
Average two-wheels vehicle				1244

Source: Survey result, in 2005.

The table 3 shows the highest accumulation of four-wheel vehicles is on Sunday, 23-01-2005 at 9:15 am to 09:30 am about 222 vehicles and the highest two-wheel accumulation occurs on Sunday, 23-01-2005 at 09:00 to 09:15 about 1365 vehicle.

Table 4
The accumulation of parking on Jalan Sulawesi (*On Street Parking*)

Day/Date	Vehicles type	Vehicles number	The highest accumulation time	The highest accumulation
Wednesday,	Four-wheels	26	07.45 - 08.00	5
19-01-2005	Two-wheels	415	09.15 - 09.30	62
Sunday,	Four-wheels	36	07.30 - 07.45	6
23-01-2005	Two-wheels	806	09.15 - 09.30	96
Average four-wheels vehicle				5,5
Average two-wheels vehicle				79

Source: Survey result, in 2005

Table 4 shows four-wheel vehicles, the highest accumulation occurs on Sunday, 23-01-2005 at 07:30 am to 07:45 am about six vehicles. The two-wheel vehicles, the highest accumulation occurred Sunday 23-01-2005 about 96 vehicles.

3.3 Parking Duration

The duration of parking is the time is taken to stop any vehicle in the parking area is expressed in hours and parking area will be able to serve more that are used by vehicles in a longer time. In accordance with the calculation in the table parking duration (*in the annex*) it was obtained parking duration description as follows:

a) Pasar Badung parking area (*off street parking*)
   Two-wheeled vehicle
   1) On Wednesday, 19-01-2005, % cumulative amount was 46.34% of parking for a short period of time was 100%.
   2) On Sunday, 23-01-2005, % cumulative amount was 62.28% of parking for a short period of time was 100%.

   Four-wheel vehicle
   1) On Wednesday, 19-01-2005, % cumulative amount was 35.52% of parking a short time was 100%.
   2) On Sunday, 23-01-2005, % cumulative amount was 60.16% of parking a short time was 100%.

b) Parking on Jalan Sulawesi Denpasar (*on-street parking*)
   Two-wheel vehicle
   1) On Wednesday, 19-01-2005, % cumulative amount was 59.76% of parking a short time was 100%.
   2) On Sunday, 23-01-2005, % cumulative amount was 66.50% of short time parking of time was 100%.

   Four-wheel vehicle
   1) On Wednesday, 19-01-2005, % cumulative amount of short time parking 19.23% about 100%.
   2) On Sunday, 23-01-2005, % cumulative amount was 27.77% of short time parking was 100%.

3.4 Level of Parking Turnover

The parking turnover rate indicates the use level of the parking area in the amount obtained by dividing the total number of vehicles parked for a certain time of the survey conducted by the existing plots number. The survey results can find the amount of parking turnover rate as follows:

Table 5
The level of parking turnover for two-wheel at Pasar Badung area (*Off Street Parking*)

Day/Date	Number of Vehicles (Nt)	Number of Area (S)	Survey period (TS)	Level of turnover TR = Nt/(S.TS)
Wednesday, 19-01-2005	3392	1600	8	0,265
Sunday, 23-01-2005	3672	1600	8	0,286
Average				0,2755

Table 6
The level of four-wheel vehicle parking turnover at Pasar Badung area (*Off Street Parking*)

Day/Date	Number of Vehicles (Nt)	Number of Area (S)	Survey period (TS)	Level of turnover TR = Nt/(S.TS)
Wednesday, 19-01-2005	1022	300	8	0,425
Sunday, 23-01-2005	1137	300	8	0,473
Average				0,449

Table 5 and 6 show that for each hour of the airport parking plot 1 area vehicle in Pasar Badung parking area (*off street parking*).

Table 7
The level of two-wheel vehicle parking turnover at Pasar Badung area (*Off Street Parking*)

Day/Date	Number of Vehicles (Nt)	Number of Area (S)	Survey period (TS)	Level of turnover TR = Nt/(S.TS)
Wednesday, 19-01-2005	415	80	8	0,648
Sunday, 23-01-2005	806	80	8	1,259
Average				0,953

Table 8
The level of four-wheel vehicle parking turnover on Jalan Sulawesi (*Off Street Parking*)

Day/Date	Number of Vehicles (Nt)	Number of Area (S)	Survey period (TS)	Level of turnover TR = Nt/(S.TS)
Wednesday, 19-01-2005	26	7	8	0,464
Sunday, 23-01-2005	36	7	8	0,642
Average				0,553

3.5 The average parking duration

Is the duration to each vehicle that was in the parking area. From the data is able to show the average of parking duration at research location as shown in the following table:

Table 9
The average of parking duration at Pasar Badung parking area *(Off Street Parking)*

Day / Date	The average of parking duration of (Hours)	
	Four Wheel	Two Wheel
Wednesday, 19-01-2005	1,284	1,134
Sunday, 23-01-2005	1,149	1,121
Average	1,2165	1,1275

Table 9 above shows that the average of parking duration for two-wheel vehicles, four-wheel can be classified as a parking time being.

Table 10
The average of parking duration on Jalan Sulawesi Denpasar *(On Street Parking)*

Day / Date	The average of parking duration of (Hours)	
	Four Wheel	Two Wheel
Wednesday, 19-01-2005	1,496	1,137
Sunday, 23-01-2005	1,619	1,080
Average	1,557	1,108

Table 10 above shows that the average of parking duration for two-wheel vehicles, four-wheel parking time can be classified as being in the range of 1-4 hours.

3.7 The analysis of parking area available

The analysis of parking area available is meant to determine how much the capacity of the parking area is available for the needs of each hour and how many vehicles can be parked in research location during the survey.

3.8 Parking capacity

Parking capacity is how much capacity is available at any given time the research location. The survey result on the data and data analysis can be concluded the parking capacity spaces on research location according to the existing formula.

Table 11
The capacity of Parking space in Pasar Badung (Off Street Parking)

Day / Date	Vehicle type	Number of area (S)	The average of parking area (D) (Jam)	Parking capacity (vehicle/hour) (S) / (d)
Wednesday,	Four-wheels	300	1,284	233,64
19-01-2005	Two-wheels	1600	1,134	1410,93
Sunday,	Four-wheels	300	1,149	261,09
23-01-2005	Two-wheels	1600	1,121	1427,29
Average	Four-wheels			247,36
	Two-wheels			1419, 11

Table 12
The capacity of parking space on Jalan Sulawesi Denpasar *(On Street Parking)*

Day / Date	Vehicle type	Number of area (S)	The average of parking area (D) (Jam)	Parking capacity (vehicle/hour) (S) / (d)
Wednesday,	Four-wheels	7	1,496	4,68
19-01-2005	Two-wheels	80	1,137	70,36
Sunday,	Four-wheels	7	1,619	4,32
23-01-2005	Two-wheels	80	1,108	72,20
Average	Four-wheels			4,5
	Two-wheels			71,28

Table 11 shows that 300 parking area in the parking space of four-wheel vehicles has a capacity per hour of 247.36 wherein the highest demand is parking means it can accommodate 222 vehicles that want to park. For 1600 space that exists for two-wheel vehicles have a capacity per hour 1419.11 wherein the highest demand is parking vehicle/hour 1365 means it can accommodate vehicles that want to park.

Table 12 of seven parking space for four-wheel vehicles have a capacity of its capacity per hour 4.5 vehicle/hour wherein the parking demand for 6 vehicles means that demand exceeded the capacity of existing parking. Eighty space for parking two-wheel vehicles per hour 71.28 has a capacity vehicle/hour, whereas, the demand amounted to 96 vehicles exceeded the existing capacity.

3.9 The capacity of parking space (Parking Supply)

Parking Supply can provide the number of measure limit of vehicles that can be parked in the research location during the survey period. Parking supply according to Oppenlender (1976) is calculated using the formula:

$$P = \left(\frac{\Sigma S \times T}{D} \times F \right)$$

Description: S = number of parking spaces
T = survey duration
D = average of parking duration
F = insufficiency factor = 0,9

The amount of *parking supply* is tabulated as follows:

Table 13
The amount of *Parking Supply* in Pasar Badung parking area *(Off Street Parking)*

Day / Date	Vehicle type	Survey duration (T) (hour)	Average Parking duration (D) (hour)	Number of space (S)	Parking Supply (vehicle) $\frac{S.T}{D} \times 0,90$
Wednesday,	Four-wheels	8	1,284	300	1682,24
19-01-2005	Two-wheels	8	1,134	1600	10158,73
Sunday,	Four-wheels	8	1,149	300	1879,89
23-01-2005	Two-wheels	8	1,121	1600	10276,53
Average of Four-wheels		1781,06			
Average of Two-wheels		10217,63			

Table 13 shows that the parking supply is greater than demand. The average four-wheel parking supply vehicles 1781.06 with a volume of 1022 vehicles Wednesday, Sunday, 1137 vehicles, whereas, the two-wheeler parking supply with volume 10217.63 parking Wednesday 3392 and 3672. This means that the capacity that already meets demand parking the four-wheeled vehicle and two wheels.

Table 14
The amount of *Parking Supply* on Jalan Sulawesi Parking (*On Street Parking*)

Day / Date	Vehicle type	Survey duration (T) (hour)	Average Parking duration (D) (hour)	Number of space (S)	Parking Supply (vehicle) $\frac{S.T}{D} \times 0,90$
Wednesday,	Four-wheels	8	1,496	70	33,68
19-01-2005	Two-wheels	8	1,137	80	506,59
Sunday,	Four-wheels	8	1,619	7	31,13
23-01-2005	Two-wheels	8	1,108	80	519,85
Average of Four-wheels		32,40			
Average of Two-wheels		513,22			

Table 14 shows that the parking supply for four-wheel about 32,40 whereas, parking demand on Wednesday is 26 vehicles and on Sunday is 36 vehicles. The parking supply for two-wheels is 523,22 whereas, a parking demand on Wednesday is 415 vehicles and on Sunday is 806 vehicles. In term of this, it is to show that for two wheels on Sunday for two-wheels and parking supply of four-wheels less than parking demand, thus, the number vehicles parking was larger than parking capacities.

3.10 Parking Index

The parking index is the ratio of parking accumulation with parking capacity, and can be used as a measure in assessing the parking spaces needs. In order to calculate the parking index can be counted by the equation:

$$IP = \frac{\text{Parking accumulation}}{\text{Parking capacity}}$$

In term of this case, the parking index that is highest obtained from the comparison between the highest parking accumulations to parking capacity.

Table 15
Parking index in Pasar Badung parking area *(Off Street Parking)*

Day / Date	Vehicle type	Highest accumulation time	Highest accumulation number	Parking capacity	Parking index
Wednesday,	Four-wheels	08.45-09.00	194	233,64	0,830
19-01-2005	Two-wheels	10.00-10.15	1123	1410,93	0,795
Sunday,	Four-wheels	09.15-09.30	222	261,09	0,850
23-01-2005	Two-wheels	09.009.15	1365	1427,29	0,956

In accordance with the survey results and analysis of data on Wednesday and Sunday for four-wheels and two-wheels vehicle on parking available index <1, this means the need for parking is under existing capacity.

Table 16
Parking index on Jalan Sulawesi (*On Street Parking*)

Day/Date	Vehicle type	Highest accumulation time	Highest accumulation number	Parking capacity	Parking index
Wednesday,	Four-wheels	07.45-08.00	5	4,68	1,068
19-01-2005	Two-wheels	09.15-09.30	62	70,36	0,881
Sunday,	Four-wheels	07.30-07.45	6	4,32	1,388
23-01-2005	Two-wheels	09.15-09.30	96	72,20	1,329

In accordance with the survey results and analysis of data on Wednesday for a two-wheeled vehicle in Jalan Sulawesi obtained indexes parking <1, which means the need for parking below the capacity of existing, while Wednesday's four-wheeled vehicles and Sunday for two-wheeled vehicles and four wheels found parking index> 1, this implies the need for parking on top or exceeds existing capacity.

4. Conclusion

In regarding the research results that includes the collecting of the data and analysis of data in the discussion of Pasar Badung capacity, therefore, it can be concluded finding as for the table as follows:

In accordance with the survey results and analysis of data on Wednesday for two-wheels vehicle on Jalan Sulawesi is obtained parking indexes <1, which means the need for parking under the existing capacity, whereas, on Wednesday four-wheel vehicles and on Sunday for two-wheel vehicles and four-wheels found parking index >1, this implies the parking needs on top or exceeds existing capacity.

4.1 The Characteristics Pasar Badung Parking Today (Off Street Parking)

Table 17
The characteristics of Pasar Badung parking

Data Analysis Results	Two-Wheeled Vehicle	Four-Wheel Vehicles
Average volume parking	441,5 vehicles / hour	135,5 vehicles / hour
Highest parking accumulation	1365 is occurred on Sunday, 23-01-2005	222 is occurred on Sunday, 23-01-2005
Percentage of lowest parking cumulative	46,34% is occurred on Wednesday, 29-01-2005	35,52% is occurred on Wednesday, 19-01-2005
Average parking duration	1,1275 hour	1,2165 hour
Parking turnover level	0,2755 hour	0,449 hour

Table 18
The Characteristics of Parking on Jalan Sulawesi *(On Street Parking)*

Data Analysis Results	Two-Wheeled Vehicle	Four-Wheel Vehicles
Average volume parking	76,5 vehicles / hour	45,5 vehicles / hour
Highest parking accumulation	965 is occurred on Sunday, 23-01-2005	62 is occurred on Sunday, 23-01-2005
Percentage of lowest parking cumulative	59,76% is occurred on Wednesday, 29-01-2005	19,23% is occurred on Wednesday, 19-01-2005
Average parking duration	1,108 hour	1,557 hour
Parking turnover level	0,953 hour	0,553 hour

In accordance with the above data it can be concluded that the characteristics of parking in Pasar Badung at the time of the study have different characteristics, towards its peak level, occurred on Sunday, January 23rd, 2005 as the day is a holiday and the next day the day Monday, January 24, 2005, is the festival day of Hindu (*Purnama/full moon*).

4.2 The Capacity of Pasar Badung Parking Area

Table 19
The Capacity of Pasar Badung Parking Area Badung *(Off Street Parking)*

Data Analysis	Two-Wheeled Vehicle	Four-Wheel Vehicles
Highest parking accumulation average	1244 vehicles	208 vehicles
Average parking capacity	1419,11 vehicles / hour	247,36 vehicles / hour
Average parking index	0,87	0,84
Average parking demand	441,5 vehicles / hour	135,5 vehicles / hour
Average parking volume	3532 vehicles	1079,5 vehicles
Average *Parking supply*	10217,63 vehicles	1781,06 vehicles

Table 20
The capacity of parking on Jalan Sulawesi *(On Street Parking)*

Data Analysis	Two-Wheeled Vehicle	Four-Wheel Vehicles
Highest parking accumulation average	79 vehicles	5,5 vehicles
Average parking capacity	71,28 vehicles / hour	4,5 vehicles / hour
Average parking index	1,105	1,228
Average parking demand	76,5 vehicles / hour	4,5 vehicles / hour

Average parking volume	610,5 vehicles	31 vehicles
Average *Parking supply*	513,22 vehicles	32,40 vehicles

It can be concluded that there are issues towards parking on Jalan Sulawesi at certain times are approximately at 7:30 am to 9:30 am wherein at this time occurred the highest parking accumulation, for two-wheels vehicles parking index average is the highest accumulation achieves 1,105 and for four-wheel vehicles parking index averaged about 1.228 that means at that parking demand time exceeds existing capacity. Whereas, in the parking area for two-wheels in Pasar Badung parking index average at the highest accumulation of 0.87 and a four-wheel parking index of 0.84. This means that there was no trouble for parking requirements under the existing capacity.

4.3 The Utilization System of Parking in Pasar Badung

a) The activities parking of vehicles on the users prefer to take benefit of the parking spaces located on Jalan Sulawesi than parking area in Pasar Badung.
b) The parking spaces on Jalan Sulawesi often cause congestion or traffic, especially, between 07:30 am to 09:30 am because its parking made less organized and less convenient, especially for public transport drivers were arbitrarily impressed use the parking area. The facilities as well parking spaces can not accommodate vehicles that will be parked

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Biography of Author

I Ketut Sutapa, S.ST, MT. was born on June 26th, 1967. He is a senior lecturer in Bali State Polytechnic, Bukit Jimbaran, Kuta, Badung, Bali. He is recently going to finish his Doctorate Degree on July 20th, 2016 at the University of Udayana. He researches interest in transportation and engineering as well his papers have been published at many publishers especially in International Journals.

Email: iketutsutapa76@yahoo.com