Performance Analysis of Roads in Denpasar City (Case Study: Denpasar East)

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Abstract. On several roads in the city of Denpasar, traffic problems such as congestion, queues and delays are frequent occurrences, especially at certain hours (peak hours), namely when people want to move to the same destination and at the same time such as school activities, offices and so on. One of the causes of the traffic problems above is an increase in the volume of vehicles every year which is not followed by an increase in road length or an increase in road capacity. Traffic problems that occur include traffic jams that are common and often occur in big cities which in turn causes the city to be inefficient and can result in significant economic losses and another traffic problem that cannot be ignored is the problem of traffic accidents, where safety, smoothness and comfort of road users are factors that are disrupted if an accident occurs. Road accidents always have an impact on damage to vehicles involved in accidents and losses for accident victims and road users in the vicinity. In this case, it is necessary to solve the complex traffic problems with planned and directed traffic management, so that one congestion at a point of congestion also causes congestion in other parts of the road. In order to achieve a comprehensive, integrated and planned traffic management, it is necessary to first know the characteristic behavior of traffic flow, such as the characteristics of volume, speed and density. Based on the traffic characteristics, the performance parameters of the road section will be obtained so that it can be seen what the performance of the road section is. The results of the analysis of the performance of roads in the city of Denpasar, especially in East Denpasar in the study showed that the roads that had the highest level of service were Jalan W.R Supratman with a V/C Ratio value of 0.76 with the service level at level D, the road with the lowest speed. is the Jalan Hayam Wuruk section with the largest speed of 20.0 km/hour and the road section that has the lowest density is Jalan Sudirman which is 39.12 pcu/km.

Keywords: level of service; road performance; road section

1. Introduction

The rapid development of the city cannot be separated from the increase in traffic that is increasingly dense and the public's demand for increasingly large vehicles requires attention and integrated handling of transportation facilities and infrastructure. Traffic problems that often occur and become a scourge for the community are traffic jams. Congestion is a common problem and occurs in large cities which in turn causes the city to become inefficient and can result in significant economic losses.

The increasing volume of vehicles in almost every urban road segment, especially in Denpasar City, causes traffic problems to increase. City people are starting to switch from public transportation to private transportation with the assumption that private vehicles are more comfortable, safe and effective in terms of travel time.

On several roads in the city of Denpasar, traffic problems such as congestion, queues and delays often occur, especially at certain hours (peak hours), namely when people want to move to the same destination and at certain times. at the same time such as school activities, office buildings and so on. In this case, it is necessary to solve the complex traffic problems with planned and directed traffic management, so that a traffic jam at a point of congestion also causes congestion in other parts of the road. In order to achieve a comprehensive, integrated and planned traffic management, it is necessary to first know the characteristic behavior of traffic flow, such as the characteristics of volume, speed and density. Based on traffic characteristics, road performance will be obtained which can be used as a guide to provide solutions to traffic characteristics problems.

2. Literature review
2.1 Traffic Flow characteristics

Traffic characteristics are a measure used to measure traffic activities in the transportation system.

Traffic flow characteristics can be classified into two categories, namely:

1. Macroscopic parameters, which characterize traffic flow as a unit (system), in order to obtain an overall operational picture of the system.

Example: flow rates, traffic volume, average speeds, density rates.

2. Microscopic parameters, which characterize the behavior of each vehicle in traffic flows that influence each other.

Example: time between (time headway), speed of each (individual speed), distance between (space headway).

2.2 Traffic Composition

The traffic flow in the field is heterogeneous. Where a number of vehicles with various types, sizes and characteristics form a traffic flow. This diversity forms different traffic characteristics for each composition and affects the overall traffic flow. Taking into account these conditions, a quantity is needed to express the effect of a type of vehicle on the overall traffic flow. The passenger car unit (pcu) is a quantity that states the equivalence of the effect of each type of vehicle compared to the type of passenger vehicle. With this magnitude, each composition can be assessed. The following is a list of passenger car units.

Table 1. List of Passenger Car Units

Number	Vehicle Type	The passenger car unit (pcu)
1	light vehicle	1.00
2	heavy vihicle	1.20
3	motorcycle	0.25
4	Un- motorized	0.80

Sumber: Departemen Perhubungan, 1997

2.3 Macroscopic Parameters

The traffic characteristics described in this study are about the macro characteristics of traffic flow, namely volume (V), speed (S) and density (D).

2.3.1 Traffic Volume

Traffic volume is defined as the ratio between the number of vehicles passing a certain point with the observation time interval. Based on the vehicle adjustment to the passenger car unit (pcu), the traffic volume can be calculated by the following formula (Morlok, 1991):

$$q = \frac{n}{t}$$

with:
q = traffic volume (pcu/hour)
n = number of vehicles that passed during the observation time (pcu)
t = observation time interval (hours)

2.3.2 Traffic Speed

Traffic speed is the ratio between the distance traveled and the time it takes to travel the road (Morlok, 1991). The formula for speed can be written:

$$u = \frac{\sum_{i=1}^{n} Si}{\sum_{i=1}^{n} mi}$$

Where :
μ = space average velocity (m/s)
Si = distance traveled by vehicle i on the road (1,2,....) (m)
mi = time spent by vehicle i on the road (m/s)
n = number of vehicles observed

2.3.3 Traffic Density

Traffic density is the number of vehicles occupying a length of road or lane. The value of traffic density can be formulated as follows:
k = q/p
Where:
k = traffic density (pcu/km)
q = traffic volume (pcu/km)
u = average speed of traffic (km/h)

3. Research methods
3.1 Research sites

This research was conducted on roads with the status of provincial roads in Denpasar City, a case study of roads in East Denpasar.

3.2 Research Stages

The stages of the research are described in the framework with the flow chart below:
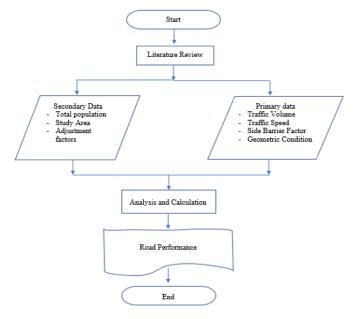

Figure 1. Research Flow

The stages of the research to be carried out are as follows:
1. Preparation stage
   Conduct a literature study in order to sharpen research problems, theories and concepts that can explain the research focus based on the results of the initial survey.
2. Data collection stage
   a. Secondary data collection
      The comprehensive methodology developed begins with the data collection stage, in this case secondary data. The data collected in this stage is in the form of identification of 3 (three) main problems, namely:
      1) Population data in Denpasar City;
      2) Study area area; and
      3) Adjustment factors
   b. Primary data collection
      A table is presented about some of the primary data needed in the research are as follows.

Table 2. Primary Data Required in Research

No	Type of Survey	Information target
1	*Traffic Counting*	1. Traffic volume 2. Traffic speed
2	Existing condition survey	1. Geometric data of the research location road 2. Side barriers at the research site

4. Results and Discussion
4.1 Road Performance

Based on the results of traffic data, then the performance of roads in East Denpasar is obtained as follows.

No	Roads	Road Status	Capacity	Volume pcu/Hour	V/C Ratio	Level of Service
1	WR Supratman	Provincial road	3360,61	2545,3	0,76	D
2	Nusa Indah	Provincial road	3340,71	2798,8	0,84	D
3	Hayam Wuruk	Provincial road	1853,68	1568,9	0,85	E
4	Sudirman	Provincial road	5241,14	4557,40	0,87	E

4.1.1 Road Speed

The speed of travel on a road segment can be determined by dividing the length of the road segment by the travel time where data about the speed of this trip can be obtained from the survey results as presented in the following table:

No	Roads	Average Speed- Segment (Km/Hour)
1	WR Supratman	30,0
2	Nusa Indah	25,0
3	Hayam Wuruk	20,0
4	Sudirman	42,0

4.1.2 Road Density

Density (vehicle minutes per kilometer) is a combination of speed and traffic volume and measures the total travel time required to cover each road segment as presented in the following table:

No	Roads	Road Density (pcu/km)
1	WR Supratman	63,87
3	Nusa Indah	96,71
2	Hayam Wuruk	116,45
4	Sudirman	39,12

5. Conclusion

Based on the results of the analysis that has been carried out, the characteristics of the traffic flow in East Denpasar are as follows.

Based on the degree of saturation, the road that has the highest level of service is Jalan W.R Supratman with a V/C Ratio value of 0.76 with the service level being at level D.

Based on speed, the road segment that has the lowest speed is on Jalan Hayam Wuruk where this road section has the largest speed at 20.0 km/hour.

The road section that has the lowest density is on Jalan Sudirman, which is 39.12 pcu/km.

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