Evaluation of trip generation and trip attraction of shopping centre on traffic performance in Denpasar city

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Abstract. Teuku Umar St is one of the roads in Denpasar City with very high vehicle density and side barriers. This is due to the large number of activity centers that result in trip generation that affect the traffic performance, one of which is the Level 21 shopping centers. Traffic surveys are carried out on Teuku Umar St and Diponegoro St which are the exit gates of Level 21. Results of this evaluation are as follows (1) The traffic volume on Teuku Umar St is 4659.5 pcu/hour, with a V/C Ratio of 0.87 having a level of service at the level of "E". (2) Traffic volume on Diponegoro St is 1948.5 pcu/hour, with a V/C Ratio of 0.71 having a level of service level "C". (3) Operations of Level 21 shopping centers affect the performance of the Teuku Umar St segment by 315 pcu/hour for pulling and affecting the performance of the Diponegoro St section of 260.6 pcu/hour for generation. (4) Level 21 shopping center operations affect the performance of Teuku Umar St segment by 13.4% and affect the performance of Diponegoro St by 13%. Through the results of this study, it is necessary to study management handling of traffic.

1. Introduction
Transportation is a very important tool in supporting the success of the development, especially in supporting community economic activities [1,2]. Transportation can be explained from a micro-transportation system, which consists of an activity system, a transportation infrastructure network system, and a traffic movement system, where each land use or activity system has certain activities that will generate movement and attract movement in the process of fulfilling needs [3,4]. From this movement process that causes transportation problems. Transportation problems occur because there is no alignment between urban planning and development in the form of land use with planning and development of transportation in accordance with the direction of the city's development. In other words, problems occur because of the imbalance between transportation needs and the provision of transportation infrastructure and facilities [5]. One of the important things in traffic is that there is a high volume of traffic throughout the day or between days of the week, as well as for daily periods during peak hours where there are many trips between centres of activity [6]. To overcome transportation problems caused by movement activities, an analysis of traffic impacts is carried out. Every plan to build a centre for activities, settlements, and infrastructure that will cause disturbances in security, safety, order and smooth traffic and road transportation must be carried out to analyse the impact of traffic [7].

The current condition, the Teuku Umar St section is very dense with very high side barriers coupled with the operation of the Level 21 shopping centre which of course will result in the addition of loading traffic by private vehicles that will enter the centre of the activity. Through this study, several problems...
can be formulated, namely the performance of the Teuku Umar and Diponegoro St segments as well as the rise and pull of shopping centres that affect the performance of the road.

The Sakura Mart shopping centre, located on Trans Sulawesi Road, only affects 9.07% of traffic performance [8]. Analysis of traffic impact analysis due to the existence of a shopping centre in the Pangkal Pinang Morning Market area on Road Performance. The results of the study concluded that the traffic performance conditions that occur due to the existence of shopping centers in the Morning Market Area of Pangkal Pinang City with a degree of saturation (DS) of 0.11, FV of 38.42 km / hour which at the conditions on the ground have speed (V) which is taken by the car 23.67 km / hour, while the motor speed is 29.93 km/hr, and the road capacity (C) is 4095.6 pcu/hour. Traffic problems that occur as a result of the Morning Market are influenced by several factors, namely vehicles parked on road bodies that almost use half the road body, pedestrians, street vendors, and correlations between vehicles entering and leaving the Morning Market [9].

Analyze the impact of traffic (Andalalin) in the Lippo Plaza Kairagi Manado area. In this study, it was concluded that the highest number of visitors was 5349 people per day, where the trip generation only affected 15% of the performance of Jalan A.A. Maramis and Polytechnic Roads [10].

2. Road performance

Road performance is a quantitative measurement that describes certain conditions that occur on a road [11]. In determining the performance of the road using several parameters, namely as follows [12,13]

2.1. Traffic flow and composition

The value of traffic flow (Q) reflects the composition of the traffic, by stating the current in the passenger car unit (pcu), where each value of the traffic flow is converted into a passenger car unit using the equivalent passenger car (epc).

2.2. Capacity

Capacity is the maximum number of motorized vehicles that cross a certain cross section on a road in a certain time unit. The amount of road capacity is formulated as follows:

\[ C = C_0 \times FCw \times FCsp \times FCsf \times FCcs \]  

Information:
- \( C \) = Capacity
- \( C_0 \) = basic capacity
- \( FCw \) = Traffic width adjustment factor
- \( FCsp \) = direction separator adjustment factor
- \( FCsf \) = Factor adjusting for side barriers
- \( FCcs \) = City size adjustment factor

2.3. Degree of saturation

Degree of saturation (DS) is defined as the ratio of road to capacity, which is used as the main factor in determining the level of performance of intersections and road segments. The basic equation to determine the degree of saturation is as follows.

\[ DS = \frac{Q}{C} \]  

Information:
- \( DS \) = Degree of saturation
- \( Q \) = Traffic flow (pcu/hour)
- \( C \) = Capacity (pcu/hour)
2.4. Level of service
It is a quantitative and qualitative measure that describes the operational conditions of traffic [14]. The V/C ratio is the ratio between the volume of the segment and the capacity of the road. The volume of a segment is obtained by conducting a survey of classified traffic enumeration or movement between zones that burden the road segment. V/C ratio can be used to assess the performance and service level of the road segment [15].

3. Methodology
The data needed in this study includes primary data, as follows.

3.1. Geometric road survey
Path geometric data obtained by measuring and direct observation in the field. Data recorded includes road width, shoulder width, sidewalk width, median width (if any), number of lanes, and number of lanes.

3.2. Survey of traffic counts in sections
The survey method is carried out by calculating the cross-sectional vehicle traffic count according to the type of vehicle, carried out using a manual counting device for passing vehicles, which is carried out by observation for a certain time (15 hours or 24 hours). Data recording is done at intervals of every 15 minutes for each hour of observation. The capacity calculation refers to the 1997 Indonesia Road Capacity Manual where it uses traffic volumes from heavy vehicles, light vehicles (light vehicles / LVs), motorbikes (motorcycles / MCs), and non-motorized vehicles (un-motorized) / UM). The survey was conducted for two days, namely workdays (weekday) and weekends (weekends), each of which was carried out for 14 hours, i.e from 6:00 a.m. until 8:00 p.m.

3.3. Vehicle speed survey
This survey uses the link speed method, which is to place two surveyors at a certain distance (e.g. 50 meters) and record the travel time of the vehicle between these two points. The value taken is the average value and is carried out for each road segment that has physical /characteristic differences within the study area.

3.4. Survey of generation and attraction
The survey was conducted by recording vehicles in and out of shopping centres.

4. Results and discussion

4.1. Geometric road
Teuku Umar St has a type of road 4/2 D (4 lanes 2 way with median separator) with a width of road body of 14 meters and the width of the sidewalk left and right of the road is 1.5 m. The type of pavement for this road is asphalt and based on direct observation in the field, the condition of this road is quite good. The use of the land around the road is in the form of offices, commercial and residential areas. Diponegoro St has a type of road 2/1 UD (2 lanes one direction without median separator) with a width of road body of 11 meters and the width of the sidewalk on the left is 1.3 m and the right side of the road is 1.5 m. The type of pavement for this road is asphalt and based on direct observation in the field, the condition of this road is quite good. The use of the land around the road is in the form of offices, commercial and residential areas.

4.2. Traffic fluctuations
Data on traffic volume on the Teuku Umar St section was obtained from the results of a survey of traffic counting on the road (traffic counting). The data used for analysis is data on traffic volume during rush hour. Based on the results of the survey, traffic fluctuations were obtained as follows.
Figure 1. Traffic fluctuations on Teuku Umar St working day (a) westward, (b) eastward.
Figure 2. Traffic fluctuations on Teuku Umar St weekends (a) westbound direction, (b) eastbound direction.

Figure 3. Fluctuations in traffic on Diponegoro St (a) working days, (b) weekends.
Based on traffic fluctuations, the peak hours of Teuku Umar Road on weekdays occur at 17.00 - 18.00 WITA with a traffic volume of 4659.5 pcu/hour. While on weekends, peak hours occur at 17.30 - 18.30 WITA with traffic volume of 4224.3 pcu/hour. The highest traffic fluctuations on Diponegoro St on weekdays occur from 16.15-17.15 with a traffic volume of 1948.5 pcu/hour, while during weekends it occurs at 16.30-17.30 with a traffic volume of 1758.2 pcu/hour.

4.3. Road performance

From the results of a survey of classified traffic analysis and analysis carried out, it can be seen the value of V/C ratio on the Teuku Umar St segment as follows.

| Section Name | Volume (pcu/hour)  | Capacity (pcu/hour) | V/C Ratio |
|--------------|--------------------|---------------------|-----------|
|              | Weekday | Weekend | Weekday | Weekend | Weekday | Weekend |
| Jl. Teuku Umar | 2365.7 | 2268.0 | 2729.80 | 0.87 | 0.83 |
| Westward direction |        |        |         |       |
| Eastward direction | 2293.8 | 2007.7 | 2729.80 | 0.84 | 0.74 |
| Jl. Diponegoro | 1948.5 | 1758.2 | 2747.13 | 0.71 | 0.64 |

Based on the Table 1, it can be seen the performance of Teuku Umar St Teuku Umar St in the direction to the West at peak hours when working days have a V / C ratio of 0.87 and on weekends have a V / C ratio of 0.83. Whereas Teuku Umar St in the east direction during peak hours on weekdays has a V / C ratio of 0.84 and on weekends has a V / C ratio of 0.74. Diponegoro St has a V / C ratio of 0.71 on weekdays and 0.64 on weekends.

4.4. Speed

Speed is an indicator of traffic that can strengthen the determination of traffic performance assessment. On the road segments that were carried out by traffic counting surveys, spot speed surveys were also conducted to determine the average speed of vehicles on the road segment. This survey was carried out on the segment of Teuku Umar St with a length of observation of 50 meters.

The following is the average speed point for both directions of traffic on Teuku Umar St and Diponegoro St.

| Section Name | Speed (km/jam) |
|--------------|----------------|
|              | Weekday | Weekend |
| Teuku Umar St | | |
| Westward direction | 24.43 | 25.67 |
| Eastward direction | 21.04 | 26.32 |
| Diponegoro St | 32.69 | 35.44 |

Based on the Table 2, the speed of vehicles on Teuku Umar St on weekdays has an average of 22.67 km/hour, while on weekends has average speed of 26 km/hour. Diponegoro St has average speed of 32.69 km/h on weekdays, while on weekends 35.44 km/hour.

4.5. Generating and attraction

The magnitude of the trip and trip pull caused by the operational Level 21 Mall is based on the results of vehicle surveys in and out of the location. The survey was carried out by recording all vehicles entering the location as well as leaving the location.
Based on the results of the outgoing surveys carried out in parking lots provided by Level 21 Mall, it was found that the total trip pulls during rush hour was 315 pcu/hour, while trip generation during rush hour was 260.6 pcu/hour.

4.6. Level of service
Based on the analysis conducted, it is known that the service level of the road or level of service (LOS) on the Teuku Umar St segment with an average speed of working days is 22.67 km/hour, at the level of service "E". For Teuku Umar St with an average speed on weekends of 26 km/h, it is at the level of service "E". Diponegoro St with an average speed of 32.69 km/hour when working days are at the level of service "E" and during weekends with an average speed of 35.44 km/hour at the level of service "E".

4.7. Percentage of seizure effect and attraction to road performance
Based on the seizure data from the operations of Level 21 shopping centres, it affects 260.6 pcu/hour or 13.4% of traffic movements on Teuku Umar St where access is entered, while Level 21 shopping centres affect 315 pcu/hour or 13% of traffic movements on Diponegoro St where access is out.

5. Conclusions
Based on the results of the discussion, the conclusions are as follows: (1) The traffic volume on Teuku Umar St is 4659.5 pcu/hour, with a V / C Ratio of 0.87 having a level of service at the level of "E". (2) Traffic volume on Diponegoro St is 1948.5 pcu/hour, with a V / C Ratio of 0.71 having a level of service level "C". (3) Operations of Level 21 shopping centres affect the performance of the Teuku Umar St segment by 315 pcu/hour for pulling and affecting the performance of the Diponegoro St section of 260.6 pcu/hour for generation. (4) Level 21 shopping centre operations affect the performance of Teuku Umar St segment by 13.4% and affect the performance of Diponegoro St by 13%.

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