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Trip Rate Model of Attraction in Higher Education Zone

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Abstract: Land use and transportation have a very close relationship. As the first stage in the four-step trip demand model that trip generation can explain the relationship between the two variables. In the analysis of trip generation and attraction it can be predicted how many movements result from a certain land use. One of the land uses that have a fairly high number of perch is in the higher education zone. Sultan Agung Islamic University (Unissula) Semarang is a campus located on Jalan Kaligawe km. 4. The rise arising from the existence of the tertiary education area is a high enough tourist attraction, causing problems such as traffic jams and traffic accidents during busy times morning and evening. This study aims to analyze the trip generation of Unissula Semarang higher education which has a total building area of 102,754.40 m2 with activities in and out of vehicles both two-wheeled and four-wheeled from morning to evening. The approach used in this research is quantitative descriptive. The analytical method used is trip-rate analysis. The results of this study indicate that vehicles entering the type of car experience peak hours at 08.00 - 08.30 as many as 210 pcu / hour while motorbikes at 07.30 - 08.00 as many as 94 pcu / hour. However, cumulatively, the highest trip rate occurred at 07.30-08.00. in the amount of 0.3 pcu / hour. While the provisions of the Institute of Transportation Engineers (ITE) states that the trip rate for tertiary institutions is 0.11 pcu / hour. Thus the need for efforts to distribute vehicles so that the traffic volume density can be decomposed.

Keywords: *land use; UNISSULA campus; trip attraction; trip-rate analysis*

1. Introduction

Land use and transportation have a very close relationship, where land use is one of the driving variables (activities) or known as trip generation which is crucial in meeting the transportation needs that will be used to travel. Trip generation is part of one of the "four - step" travel demand models in a transportation system where trip generation occupies the top position, underneath there are trip distribution, mode choice and finally trip assignment. As the top in the four-step model, trip generation is crucial for subsequent travel patterns. So it is important to do the study. Trip generation is a stage to predict the number of trips generated or drawn by a place [1].

In addition to trip generation in research on transportation also has the term trip distibution, is how traffic can be generated by a particular zone distributed. Whether the direction of travel is all headed to one place or spread evenly. Travel patterns are often explained in the form of travel flows (people, vehicles, and goods) that move from the origin zone to the destination zone within a certain area and for a certain period. In general, personal travel is classified according to its main purpose [1].

Trip generation model is a modeling step which estimates the number of movements generated or originated from a zone or land use (trip generation) and the number of movements attracted to a land use (trip attraction).

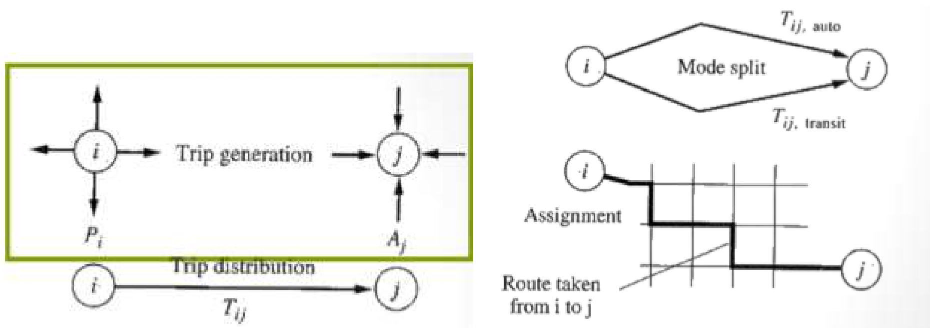

Fig. 1. Four - Step" Travel Demand Model [2]

Different types of land use will affect different traffic trips in each zone which can be indicated by the amount of traffic flow, type of traffic (motorcycle or car), and traffic at certain times (for example in the education zone usually produces the highest traffic volume / peak hour at the peak of the morning at 08.00 during the hour of entry and the peak of the evening at 16.00 when returning home) depending on the characteristics of the trip owned by a particular educational zone such as elementary school, junior high school, high school certainly with the characteristics of travel in the education area height which has a more heterogeneous type of pergerkan.

Heterogeneous travel trends in higher education environments are caused by lecture schedules that are different from working hours in general. Restrictions are often carried out to exceed normal working hours (8:00 to 16:00) this is what interests researchers to conduct research on "Trip Rate Model of Attraction in Higher Education Zone".

Research on the subject of trip generation in relation to land use has been carried out. However, the implementation of trip generation models is not possible in all regions because the model developed should be adjusted to the local conditions of the study area [3].

2. Literature Review

2.1. Trip Generation and the Factors Affecting it

Trip generation is the number of trips originating from a home zone and the number of trips drawn to a land use or destination zone. The land use function results in traffic travel [2]. Travel time depends on activities in the city, because the cause of the trip is due to the human need to carry out activities and transport goods. Each trip is always a zone of origin and destination, where the origin zone is a zone that produces travel behavior, while the destination is a zone that attracts actors to carry out activities. This traffic generation includes:
1] Traffic leaving a location
2] Traffic that goes to or arrives at a location

The output from the calculation of traffic generation in the form of the number of vehicles, people or transportation of goods per unit time, for example vehicles / hour, can easily calculate the number of people or vehicles entering or leaving a certain building area in one day (or one hour) to get a trip generation. Some factors that can affect trip generation include:
1] Pattern and intensity of land use and its development in the study area.
2] Population socio-economic characteristics of travel behavior in the study area.
3] Conditions and capabilities of the transportation system available in the study area and its development scheme.

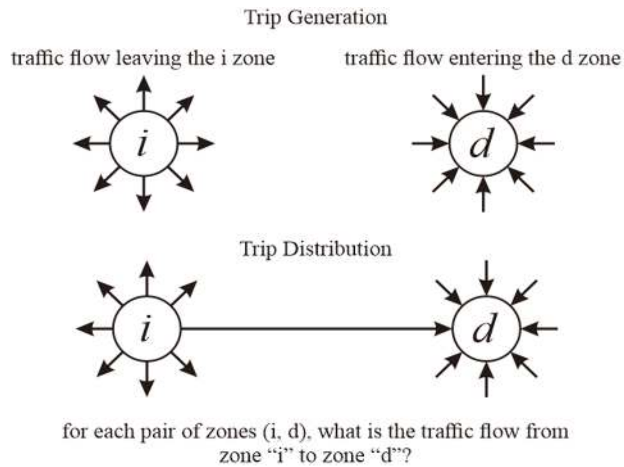

Fig. 2. Trip Generation and Trip Attraction [2]

2.2. Movement Pattern

Movement patterns are movements that occur within a certain time period between the origin zone *i* to the destination zone *d*. Urban land use patterns greatly affect a movement that is carried out in the framework of activities at the location. Trip distribution is the next stage of trip generation in a four-step travel demand model that describes interactions between land uses [2].

This can be poured into a pattern of movement distribution of interactions between land use and temporal activities. Spatial interactions between uses cause flow of movement every hour in one day and origin-destination data of a population's movements [4].

The distribution of movements shows where and from where the traffic is. The illustration is seen in the picture above [5]. Travel generation generated in a city varies and depends on the destination and type of land use [6]. Trip generation is also built by the correlation function of predictive variables, which compiles a model for observing facts at the location of a zone [7].

2.3. Land Use and Movement Pattern

Different types of land use (settlement, education and commercial) have different characteristics of traffic generation, namely:

1] Amount of traffic flow;
2] Type of traffic (pedestrians, trucks, cars);
3] Traffic at a certain time (offices generate traffic flow in the morning and evening, while shops produce traffic flow throughout the day).

Table 1. Trip Generation in Land Use of Education Zone [8]

Land Use Description	Unit	Daily Rate	Peak Hour of Adjacent Street Rate					
			AM (7-9)			AM (7-9)		
			Total	In	Out	Total	In	Out
520 Elementary Scholl	*ksf*	19.52	6.97	55%	45%	1.37	45%	55%
	students	1.89	0.67	54%	46%	0.17	48%	52%
522 Midle Sch/Jr High Sch	*ksf*	20.17	n/a	n/a	n/a	1.19	52%	48%
	students	2.13	0.58	54%	46%	0.17	49%	51%
530 High School	*ksf*	14.07	3.38	71%	29%	0.97	54%	46%
	students	2.03	0.52	67%	33%	0.14	48%	52%
534 Private School (K-8)	*students*	4.11	0.91	55%	45%	0.26	46%	54%
536 Private School (K-12)	*students*	2.48	0.80	61%	39%	0.17	43%	57%
540 Junior/Community College	*ksf*	20.25	2.07	77%	23%	1.86	50%	50%
	students	1.15	0.11	81%	19%	0.11	56%	44%

The amount and type of traffic generated by each land use are the result of social and economic parameter functions. According to Trip General Manual 10^{th} Edition Supplement issued by Institute of Transportation Engineers (ITE), trip rate in pick hour for higher education zone is 0,11 as described in Table 1.

As explained earlier, land use and transportation influence and complement each other. Directly travel patterns are influenced by the land use of an area. The trip will occur when there is a generation factor and a pull, as a result of land use. Land use factors that affect travel patterns include:

1] Population density
Influence on travel patterns through:
- Land use accessibility
  Regions with certain densities have different accessibility to public services. This has an effect on travel patterns, for example in modal selection.
- Transportasi Transportation options
- Reduced accessibility of private vehicles
  Areas with increasing density tend to reduce the level of use of private vehicles and increase alternative modes. In addition, the tendency of decreasing travel speed and distance will indirectly reduce pollution emissions.

2] Mixed Use Concept
The improvement of the concept of mix use in land use tends to reduce travel by vehicle, so there will be an increase in alternative modes one of which is via bicycle and on foot. According to a study explained that mixed-use development can reduce the movement of vehicles that are outside the area because the movement is shifting to the movement that is within the area [9]. In general the effect on travel patterns through :
a) Regional accessibility
   Increased accessibility reduces vehicle mileage.
b) Centering
   Increase the use of alternative modes, especially for commuters.
c) Network connectivity
   Reducing mileage through increased road network connectivity, and a tendency to increase the use of non-motorized transportation (cycling and walking) through increased road connectivity.
d) The concept of walking and cycling
   Using mixed-use land will trigger an increase in the use of non-motorized transportation and a reduction in the use of private vehicles.
e) Transit quality and accessibility
   Using mixed-use land will trigger an increase in transit and intermodal service and will reduce travel by car.
f) Parking provision and management
   Reducing parking provision, progressive parking rates, and implementing parking management strategies can reduce the use of private vehicles.
g) Site design
   The multi-modal footprint design can reduce the use of private vehicles, especially if implemented together with improving transit services.
h) Mobility management
   Can reduce travel by private vehicles by reducing the need for increased road and parking facility capacity, providing incentives for businesses and consumers for grouped and more accessible development with increased transportation options

To estimate total movement in mixed-use development requires the formulation of equations with different inputs which can predict movements both within and outside the region [10].

3. Research Methods

The approach used in this research is quantitative descriptive. The quantitative descriptive approach is a research approach based on the figures obtained from the results of surveys and observations in the area of observation, namely the tertiary education area of the UNISSULA Campus in Semarang. Trip rate analysis is used to analyze trip generation by comparing the number of vehicles entering with the building area.

The research location is in the Sultan Agung Islamic University (Unissula) Semarang higher education area, located on the primary arterial road, Jalan Kaligawe km. 4. The time of sampling is carried out when the campus activities begin until the end of the lecture, which starts at 6:00 to 17:00 on Monday, January 6, 2020. The selection of the duration of data collection is due to the hours when the commencement of college activities and going to work . Travel behavior in Indonesia generally travels to activity centers in the morning, and returns to the place of residence / rest in the afternoon, evening and night. [11].

For trip generation data analysis using trip rate analysis method. Data to calculate trip rates are obtained from field surveys. To calculate the trip rate the following formula is used [12]:

$$\frac{X}{TR} = \frac{X'}{100\ m^2} \tag{1}$$

TR : Trip Rate Value
X : Number of vehicles going in / out (pcu/ hour) at the comparison location
X' : Building area at comparison location (pcu/hour)

4. Statistical Analysis of Data

4.1. Traffic Volume

The volume of vehicle traffic both cars and motorbikes is used to determine the value of vehicle generation in the Unissula tertiary education area. Therefore this vehicle volume data is very important in order to get a picture of the number of vehicles entering, peak hours and also traffic density trends. Traffic volume data is calculated on weekdays ie Monday on January 6 starting at 6:00 to 17:00 with recording intervals every 30 minutes. The following are vehicle volume data at Unissula College:

Table 2. Travel data on the UNISSULA Campus

Time	Cars	Motor Cycles	Time	Cars	Motor Cycles
06:00-06:30	50	202	12:00-12:30	72	75
06:30-07:00	86	300	12:30-13:00	53	345
07:00-07:30	180	412	13:00-13:30	45	214
07:30-08:00	210	470	13:30-14:00	57	146
08:00-08:30	100	581	14:00-14:30	59	102
08:30-09:00	125	527	14:30-15:00	57	86
09:00-09:30	98	480	15:00-15:30	53	230
09:30-10:00	102	412	15:30-16:00	30	150
10:00-10:30	103	216	16:00-16:30	35	70
10:30-11:00	50	96	16:30-17:00	28	50
11:00-11:30	30	80			
11:30-12:00	67	70			
			Total	**1.690**	**5.314**

Based on the data in Table 2 above, the highest number of vehicles entering the types of cars going to Unissula is at 07.30-08.00 with a total of 210 units while on motorbikes is at 08.00-08.30 with 581 units. From the table it can also be said that morning time is the highest peak of vehicles entering the Unissula college because lecture schedules generally begin in the morning.

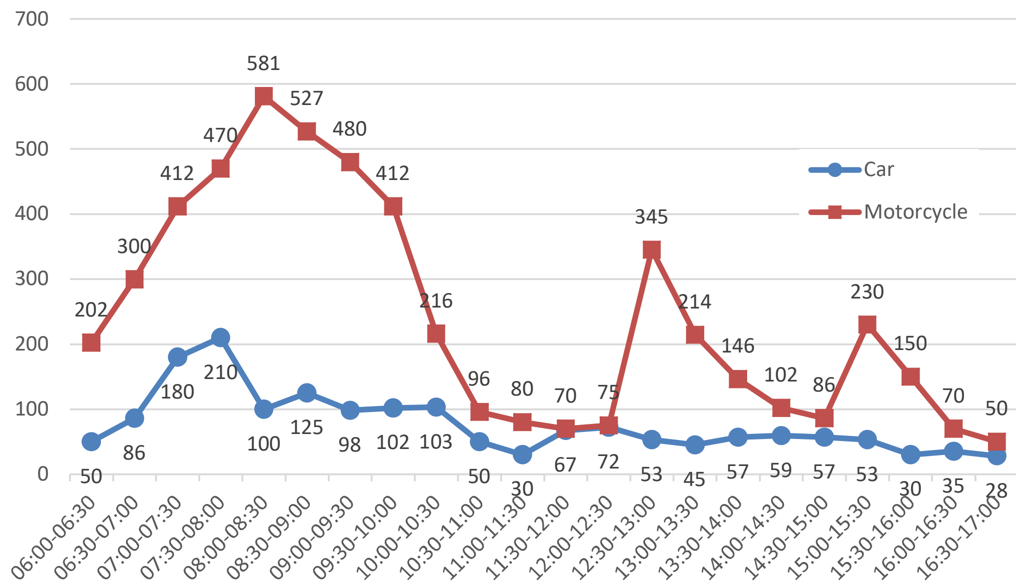

Fig. 3. Image Number of Vehicle Volumes Entered (Vehicle / hour)

Based on the graphic image above, we can get a picture of vehicle traffic as follows:

1] Only two types of vehicles entered the Unissula tertiary education area, namely cars and motorbikes; with peak hours:
   a) Cars = 210 pcu/hour
   b) Motor Cycles = 94 pcu/hour

2] There is a difference in peak hours for the number of vehicles in Unissula tertiary education, namely cars at 08.00 - 08.30 while motorcycles at 07.30 - 08.00.

4.2. Trip Rate Analysis

Trip rate is one of three methods that are often used in trip generation planning besides regression analysis and category methods. Trip rate analysis is based on determining the average travel production or level of travel attraction associated with an important trip generator in the region. Unissula higher education area trip rate analysis is calculated by comparing the area of 102,754.40 m^2 per 100 m^2 with the volume of vehicles entering.

To calculate the trip rate of vehicles entering at peak hours the following formula is used:

$$\frac{\text{Vehicle entering Unissula}}{\text{Trip Rate}} = \frac{\text{Large of Unissula}}{100\ \text{m}^2} \tag{2}$$

$$\frac{304\ \text{pcu/hour}}{\text{Trip Rate}} = \frac{102754.40\ \text{m}^2}{100\ \text{m}^2} \tag{3}$$

Based on Eq (2) and (3) we can calculate the incoming trip rate in unissula college is 0,3 pcu/hour. Following are the results of trip rate analysis in the Unissula tertiary education area:

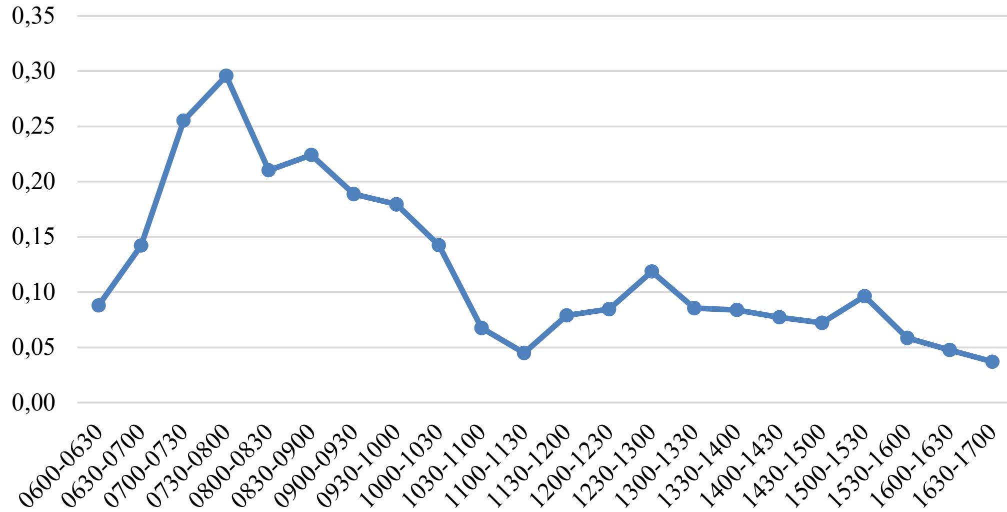

Fig. 4. Trip Rate Fluctuation in Unissula Higher Education

Based on the graph above it can be seen that the peak trip rate of 0.3 pcu / hour which occurred at 07.30 - 08.00. while the lowest trip rate is 0.04 pcu / hour which occurs at 11.00 - 11.30 and 16.30-17.00.

5. Conclusion

Based on the results of vehicle volume analysis, it can be concluded that vehicles entering the type of car (light vehicle) experience peak hours at 08.00 - 08.30 as many as 210 smp / hour while motor cycle at 07.30 - 08.00 as many as 94 smp / hour. However, both cars and motorcycles that enter the Unissula college are the same in the morning with a duration starting at 07.30-08.30. This is caused by lecture hours and offices that start in the morning.

Cumulatively, the highest trip rate occurred at 07.30-08.00 at 0.3 pcu / hour. This corresponds to the highest number of vehicles entering the Unissula college. While the lowest trip rate is towards midday (11.00 – 11.30) and the afternoon when lectures and office hours end (16.30-17.00).

Meanwhile, based on Table 1 it is stated that the trip rate at peak hours for vehicles entering the tertiary institution is 0.11 pcu / hour with a duration of time from 07.00 to 09.00. Thus the trip rate at Unissula College has exceeded the ideal trip rate conditions where the peak hour trip rate reaches 0.3 pcu / hour. So there is a need for efforts to distribute lecture hours so that the very high peak hour trip rate can be minimized.

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