Study of Traffic Management Impact on Business Facility Construction

Dody Taufik Absor Sibuea[1]

[1]Medan State University, Civil Engineering, Willlem Iskandar Street, Medan Estate, Medan, 20221, Indonesia
Email: *dodytaufikabsor[at]unimed.ac.id*

Abstract: *The development of some activity centre will affecting traffic on its surrounding area. Therefore a study is needed to assess the impact of traffic that occurs as a result of its development. Traffic management used for to determine the potential traffic impacts of a proposed traffic generator. The four main steps of the transportation planning modeling process are trip generation, trip distribution, modal split, and trip assignment. With the assumption that there is a relationship between land use intensity and the number of trips in and out of the location, traffic impact of development on the surrounding area can be forecasted.*

Keywords: transportation, modeling, traffic.

1. Introduction

The expansion of urban areas is currently considered quite rapid in line with the development of community demands for public facilities and social facilities for activities and / or businesses related to offices, shopping centers, education, and so on.

The development of an activity center that attracts or generates traffic at a certain location on the side of the road will affect the surrounding traffic, the traffic impact analysis study is used to predict whether the transportation infrastructure in the area of influence of the development can serve existing traffic, which is raised or drawn by that development [1].

The development plan of showroom on Medan Timur District is estimated to attract traffic which might affect the road performance around the location. Therefore, to calculate the impact of the development plan, it is necessary to conduct a traffic impact study, so that it can be minimized by providing the right solution.

2. Issue Identification

The problem caused by the showroom development plan is the increased traffic flow that is expected to result in a decrease in the level of service at intersections, roads, parking, public transportation facilities, and pedestrian facilities around the location. The problem formulations that can be taken in this traffic impact analysis study are as follows: traffic impact in the surrounding area; the implementation plan for road performance decreased and level of Service (LoS) around the road network, and road performance that is affected by development in the future.

3. Research Objective

The objective of this study is to predict the impact resulting from a development plan, to determine the form of improvement that needed to accommodate changes that occur as a result of a development plan, and as a monitoring and evaluation for the implementation of traffic management.

4. Research Method

Traffic impact analysis is a study that determines whether the traffic on existing roads accommodate that will result from a proposed development [2], which means to determines the potential traffic impacts of a proposed traffic generator. The traffic impact of the planned development of a new area is generally oriented towards a review of the aspects of land use development, associated with efforts to predict the amount of traffic generated and the land to be withdrawn to be planned, as well as efforts to estimate the impact on the surrounding road network. In analyzing traffic management impact requires some of the following information: existing condition, trip generation and traffic volume, trip distribution and assignment, existing and future trip volume, and road capacity analysis [3].

4.1. Model Development

Transportation model will provide an overview of the traffic in the studied area. Trip assignment around the study area is added to the base year traffic to determine a real trip assignment on the impact area with the development plan. The four steps of transportation modeling are trip generation, trip distribution, modal split, and trip assignment [4].

4.1.1. Trip Generation
The initial stage of the four steps of the modeling process is trip generation, which is accordance with the category of land use in the business area, the concept of trip attraction is used. By the assumption that there is a relationship between land use intensity and the number of trips in and out of the location, a mathematical relationship can be determined that describes the level of attraction of trips to that location.

4.1.2. Trip Distibution
Trip Distibution is basically the stage to get the origin-destination matrix (O-D Matrix) which will be used in the next process. The distribution basic is the determination of the minimum travel distance path proportional to the intensity of land use in the impact area of activity.

4.1.3. Modal Split

In this stage, there are two type of approach, which is Trip End Model and Trip Interchange Modal Split Model. In this study, Trip-end concept approach will be used to split the total person-trip into vehicle-trip.

4.1.4. Traffic Assignment

The last stage is Trip Assignment. This stage uses the MKJI method, where this stage will produce traffic performance indicators which include the degree of saturation, speed, and volume on each road [5].

4.2. Traffic Behavior

4.2.1. Traffic Volume

The traffic volume on a road varies, depending on the two-way volume, traffic direction, daily volume, monthly volume, annual volume, and on vehicle composition.

4.2.2. Road Capacity

According to MKJI (1997), road capacity analysis is expressed by equations [2]:

$$C = Co \times FCw \times FCsp \times FCsf \times FCcs \qquad (1)$$

Where:
Co = basic capacity
FC_W = correction factor for road width
FC_{SP} = correction factor for road split/direction
FC_{SF} = correction factor for side friction
FC_{CS} = correction factor for city size

4.2.3. Volume Capacity Ratio

VC ratio is one of the aspect that used to determine road performance parameter, which comparing the existing traffic condition with its capacity. Volume capacity ratio can be obtained by dividing traffic volume with road capacity.

5. Data Collection and Analysis

The data collected in this study consists of two kinds of data, which is secondary data and primary data. Secondary data is data obtained from related agencies, while primary data is data obtained through direct field surveys.

5.1. Existing Conditions

Figure 1: Study Area Zoning

Zoning: This study area is divided into two zones to facilitate the classification of vehicle movements based on the origin and destination of the trip.

Table 1: Zoning

Zone	Coverage Area	Type of Area
1	To Cemara Asri Intersection	Commercial
2	To Krakatau Ujung Street	Commercial

5.1.1. Free Flow Speed dan Model Speed

Free flow speed calculation for Cemara Street:

$$PV = (FVo + FVw) \times FFVsf \times FFVcs$$
$$= (57 + (-2) \times 0{,}95 \times 1$$
$$= 44{,}93 km/h$$

Once the free flow speed is obtained, the real speed can be determined. The actual speed calculation is a model that can be used to determine the speed for the planning year.

Table 2: Free Flow Speed Calculation

Street	Type	Width (m)	FV_0	FV_W	FFV_{SF}	FFV_{CS}	FV
Cemara	6/2 D	11,05	57	-2	0,95	0,86	44,935
Cemara 1	6/2 D	11,11	57	-2	0,95	0,86	44,935

Table 3: Model Flow Sped Calculation

Street	Type	FV	VC Ratio	Volume	Capacity	Model Speed
Cemara	6/2 D	44,94	0,21	1636,82	7764,77	42,43
Cemara 1	6/2 D	44,94	0,18	1395,79	7764,77	42,82

5.1.2. Trip Distribution

For existing conditions, the amount of trip distribution is equal as the volume of traffic flow between zones.

Table 4: Traffic Volume Percentage

No	Street	Traffic Volume	
		pcu/hour	Percentage
1	Cemara	1636,82	54%
2	Cemara 1	1395,79	46%

From the results of the volume percentage, the trip generate and attraction then distributed to the road sections. For details regarding the distribution of trips between zones in the study area as follows:

Table 5: Origin Destination Matrix

OD	1	2	Total
1	0	19656	19656
2	17292	0	17292
Total	17292	19656	36948

From the table, shown that the largest number of trips during peak hours is from zone 1 to zone 2 with a total number of trips of 19,656 trip/day.

5.1.3. Route Choice/Trip Assignment

Route choice/trip assignment aims to estimate which route will be loaded from the existing trip generation and attraction, in this analysis, route choice will be simulated by using all-or-nothing method approach with capacity restrain or the nearest route.

Table 6: Trip Assignment for Existing Condition

No	Street	Capacity (pcu/h)	Volume (pcu/h)	VC Ratio	LoS
1	Cemara	7764,768	1636,82	0,211	B
2	Cemara 1	7764,768	1395,79	0,180	A

It is found that the volume of traffic to the west is higher than that of the east. So that the VC ratio for Cemara 1 is

0.18 and to the west is 0.21 in front of the plan site.

5.2. Without Construction Condition

This stage will explain how traffic performance simulation before construction. Trip distribution before the construction as follows:

Table 7: Trip Distribution Without Construction

Zone	1	2	Total
1	0	21029	21029
2	18500	0	18500
Total	18500	21029	39530

After the trip distribution results are obtained, the next step is to assign the trip so that the road performance and network performance will be obtained.

Table 8: Road Performance for Without Construction Condition

No	Street	Capacity (pcu/h)	Volume (pcu/h)	VC Ratio	LoS
1	Cemara	7764,768	1751,19268	0,23	B
2	Cemara 1	7764,768	1493,32072	0,19	A

The road section in front of the construction site, which is Cemara, with a level of service that is still in good condition, level of service value: B.

5.3. During Construction Condition

The construction makes an additional load of 34.5 pcu / hour during the construction period because the construction attracted the trips of people working on development for this area.

Table 9: Traffic Performance on Construction Condition

No	Street	Capacity (pcu/h)	Volume (pcu/h)	VC Ratio	LoS
1	Cemara	7764,768	1671,32	0,22	B
2	Cemara 1	7764,768	1430,29	0,18	A

It is shown that there was an increase in the load during the construction period, which is not too significant so that there was only a small addition of trip attraction occur.

5.4. Trip Generation Forecasting

5.4.1. Trip Production Rate
Trip rates adopted for this study are presented in terms of the number of trips in passenger cars unit (pcu) per hour produced by the activities of the construction plan. It consists of several types of activities that affect the level of trip generation and attraction, which is service facilities. The coefficient that is used as a measure to determine the estimated travel generation and attraction at location study is the number of units.

5.4.2. Trip Generation and Trip Attraction
In the operating conditions of all buildings from the site planning, it is estimated that there will be an increase in traffic volume due to additional traffic generation and attraction from the area, as well as an increase in traffic due to vehicle growth.

Table 10: Trip Generation and Trip Attraction Calculation

Type of Land Use	Day Peak		Mid-day Peak	
	In	Out	In	Out
Showroom (pcu/unit)	13,0	57,2	18,9	13,0

In analysis trip generation and trip attraction for the designation of service activities, it is estimated that the maximum generation and attraction will occur in the morning. Analysis of peak hour generation and attraction in the study area will be simulated according to road network conditions during morning and evening peak hour. The number of trips is estimated at 70.2 pcu/hour.

5.5. Post-construction Condition (Do-nothing)

This stage will explain how traffic performance simulation after construction. However, at this stage, the codification has changed with the addition of zones for construction plan.

Trip distribution after the construction as follows:

Table 11: Trip Distribution during Operation

Zone	1	2	3	Total
1	0	21029	619	21649
2	18500	0	483	18983
3	461	225	0	686
Total	18500	21029	1102	41371

After the trip distribution results are obtained, the next step is to assign the trip so that the road performance and network performance will be obtained.

Table 12: Road Performance for After Construction

No	Street	Capacity (pcu/h)	Volume (pcu/h)	VC Ratio	LoS
1	Cemara	7764,768	2267,19268	0,29	B
2	Cemara 1	7764,768	1901,32072	0,24	A

It is shown that the road in front of the construction site has a level of service that has increased significantly but still in a good service level.

5.6. Performance Comparison

Road performance comparison for the categories that have been analyzed at the study area as follows:

Table 13: Performance Comparison

Street	Existing		With Construction		Planning Years Without Construction		Planning Years Operating	
	VC Ratio	LoS	VC Ratio	LoS	VC Ratio	LoS	VC Ratio	LoS
Cemara	0,21	B	0,22	B	0,23	B	0,29	B
Cemara 1	0,18	A	0,18	A	0,19	A	0,24	B

From the analysis that has been done, it is known that there has been a decrease in traffic performance for each condition. Before construction and after construction condition, the change in performance still in a stable condition, which is at the level of service "B" which means stable flow and low traffic density.

6. Conclusion

Study shows that the impact of business facility development on traffic performance on its surrounding area has made decreasing in traffic performance, but the decreasing in performance still in a stable condition, which is at the level of service "B" that means stable flow and low traffic density. From the analysis the following conclusions can be drawn:

1) The estimated trip generation and attraction of traffic during peak hours, if the construction has been implemented and operates optimally, it is estimated that it will generate new trips of 70,2 pcu/hour.
2) For existing conditions, the performance of Cemara Street to the west has a VC ratio of 0, 21 or has a Level Of Service "B". Meanwhile, the other direction has a VC ratio of 0,18 or has a Level Of Service "B".
3) In the conditions before construction, VC Ratio on Cemara to the west is 0,23 with Level of Service B. At the time after construction the VC ratio increases to 0,29 with level of service B.
4) In the conditions before construction, the VC Ratio on Cemara 1 to the east is 0,19 with level of service A. At the time after construction, the VC ratio increases to 0,24 with level of service B..

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