

Level of Service Analysis to the Development of Tebing Tinggi City (Case Study: Middle and East Highways/Primary Arterial Highway Traffic)

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Abstract – The aim of this research is to analyze the level of service to the development of Tebing Tinggi City. This research uses descriptive-quantitative method. The research method used is to analyze the level of service traffic (from the VCR value), the ratio of traffic volume with capacity, and speed, using MKJI 1997. The results showed that the capacity of the road on the primary arterial road network decreased significantly, the highest decrease in capacity occurred at Yos Sudarso street which was 1758, 91 smp / hour and the lowest decrease on Imam Bonjol street was 1123,37 smp / hour. With the decrease in capacity, this also causes a decrease in the level of services, where the level of service is affected by traffic volume, capacity and speed, so that the level of service on the primary arterial road network is generally stable on holidays and working days. At peak hours it is in the category of C (some roads are D and E). Grade C describes a stable state, but the speed and flow of the vehicle is controlled, the volume used is for urban road design.

Keywords – Road Capacity, Service Level

I. BACKGROUND INFORMATION

The National Center for Economic Growth in the Province of North Sumatra/National Strategic Area (KSN Mebidagro, KSN Danau Toba, Sei Mangke Seaport and Kuala Tanjung Port) requires adequate infrastructure and is expected to develop Tebing Tinggi city. With the growth center activities will also increase the volume of traffic in Tebing Tinggi city where the primary arterial road on the East and Middle highway on the national road network of North Sumatra Province is located. In addition, the through traffic on primary arterial roads in Tebing Tinggi city is mixed with local traffic, with a fairly high degree of roadside barrier.

II. STATEMENT OF THE PROBLEM

Based on the analysis results on Tebing Tinggi city Transport Master Plan on traffic volume data, it can be seen that the status of capacity in several data collection locations which are primary arterial roads are as follows:

1. Gatot Subroto Street
Gatot Subroto's road width is 10 m with four lane, two-way without median (4/2 UD) with low roadside barrier. Based on MKJI in 1997, the capacity is 600 smp / hour and highest of 800 smp / hour. Based on survey data of traffic volume in 2014 found vehicle volume 1371 PCU / hour. This indicates capacity status need to be increased.
2. Yos Sudarso Street
Yos Sudarso's pavement width is 18 m with four lane, bidirectional with median (4 / 2D) with roadside barrier. Based on the MKJI of 1997, the threshold capacity is greater than 2,000 pcu / hour. Based on traffic volume survey data of 2014 found vehicle volume 1186 PCU / hour. This indicates the moderate status of capacity.
3. Soekarno - Hatta Street
The width of Soekarno - Hatta road pavement is 13.3 m with the number of four lanes, two way with median (4/2 D) with roadside barrier. Based on MKJI in 1997, the lowest road threshold

capacity is 650 smp / hour and highest 950 smp / hour. Based on the survey data volume and traffic II 2014 found vehicle volume 1070 smp / hour. This shows the status of capacity needs to increase.

This research will be conducted to analyze the level of service (level of service) to the development of Tebing Tinggi City that is on the primary arterial road which is the East and Middle Highways on the national road network of North Sumatera Province.

A. THE OBJECTIVE OF THE STUDY:

The aim of this research is to know the decrease of level of service caused by decreasing of capacity, roadside barrier on primary arterial road, and increasing vehicle flow due to infrastructure development (road) from and to KSN Mebidangro, KSN Danau Toba, Sei Mangke Seek and Port of Kuala Tanjung.

B. RESEARCH QUESTION:

Is the development of infrastructure (roads) at KSN Mebidangro, KSN Danau Toba, SEZ Mangke Seaport and Kuala Tanjung Port, will have an impact on the decreasing level of service on the primary arterial road in Tebing Tinggi City which is the East and Middle Highway on the national road network North Sumatra Province?

C. SIGNIFICANCE OF THE STUDY:

To identified level of service based on roadside barriers, capacity and vehicle speed.

III. REVIEW OF LITERATURE

A. CAPACITY

Capacity is defined as the maximum of vehicles passing through a single point in the road of time unity. Capacity can be used to measure the facilities to be provided to meet the requirements of the level of service. This means that capacity is an important factor in the planning and operation of roads [1]. According to Tamin [2], the existing road network uses the median barrier and some are not, so in the calculation the capacity is differentiated.

B. LEVEL OF SERVICE

The level of service, is a qualitative measure describing operational conditions within a traffic flow and the perception of the driver and / or passenger of the conditions [3]. The level of service can not be seen only from the speed of a vehicle, but also can be seen from the ability to maneuver in the traffic flow and the distance between one vehicle with another vehicle because the density is the main

determinant of the level of service. The level of service can be known by using density boundary values. Based on MKJI [4], the level of service is used to know the quality of the road segment in serving the traffic flow through it.

C. VEHICLE FLOW

The flow of a vehicle on a lane of motion as suggested by Morlok [5] is determined by volume, speed, concentration and headway (the time between the initial arrival of a vehicle and the next arrival of vehicle at one point on the road).

- a. Volume is the number of vehicles traveling through a point on a lane of motion per unit time, with the following calculation:

$$Q = n/T$$

Where:

- Q = Volume of traffic passing through a point
n = The number of vehicles passing through that point in time intervals
T = Time interval of observation

- b. The concentration is the average number of vehicles per unit lane of motion in length units of time, with the following calculations:

$$k = n/L$$

Where:

- k = the vehicle's concentration on a length of lane L at a point in unit of time
n = number of vehicles on the road
L = length of the road

- a. Speed is the speed of a vehicle passing through a point on a road in a given time interval, with the following calculation:

$$V = \frac{1}{n} \sum_{i=1}^n V_i$$

Where:

- V = Average speed of time
Vi = speed of vehicle i at a point on the road

Headway is the time between two or more vehicles in

which the front of a vehicle passes through a point until the the next vehicle passes through the same point

$$\bar{h}_t = 1/q$$

Where: $\bar{h}_t$ = headway average of time

D. PARKING

Parking becomes one of the impacts of the problem if the number of vehicles visiting the activity is not in balance with the needs of the parking lot so that it uses the road as a parking area and reduces the capacity [6]. Parking on the street, although done with a good system, still inhibits the flow of vehicles because of the existing road width narrowed [6]. While off-street is parking on the land provided as a parking lot, usually parking is provided at the center of the activity. Off-street parking is one of the parking lots that can reduce the level of congestion [6]. The larger the parking corner of the vehicle, the greater the reduction of the capacity [2].

IV. RESEARCH METHODOLOGY

The research was conducted in Tebing Tinggi city on Yos Sudarso Street, H.M.Yamin street, Imam Bonjol street, Soekarno Hatta Street, Sisingamangaraja Street, and Gatot Subroto street. The roads studied are those affecting the roads that pass the vehicle from and to KSN Mebidangro, SEZ Mangke Seaport and Kuala Tanjung Port, and KSN Lake Toba are as follows:

- From Yos Sudarso street to Prof. H.M.Yamin street
- From HM, Yamin street to Soekarno Hatta street
- From HM, Yamin street to Imam Bonjol street
- From Sisingamangaraja street to Gatot Subroto street

The time of research is March to May 2017. This research is conducted by survey approach. The type of research is descriptive-quantitative. Substantially, the scope of the discussion in this study includes an analysis of the decrease in the level of services on Yos Sudarso street, HM.Yamin street, Imam Bonjol street, Soekarno Hatta street, Sisingamangaraja street, and Gatot Subroto street, to the development of Tebing Tinggi City as the East and Middle Highway. This analysis focuses on increasing vehicle flow due to the position of Tebing Tinggi city as a cross lane.

A. TYPES AND DATA SOURCES

The required data are as follows:

a. Data Primer

Primary data of this research is data obtained directly based on observation in research area. There are three types of primary data from the survey results, as follows::

1. Traffic Volume Survey

The amount of volume data is taken during peak hours on days representing the volume of traffic in a week. The determination of the peak hour is based on three things: (1) the observation in the field; (2) land use activities around the observation location; (3) the commencement of journey to and from work, journey to and from school. The peak hour is determined as follows:

- morning (06.00 - 08.00), where people start their activities such as going to school / college, work, and business activities.
- during the day (12.00 - 14.00), during which peak hours business activity, breaking hours for employees, or hours back from school.
- afternoon (15:00 - 17:00).), which is commuting hours from work and college.

While the determination of peak holiday is done based on observations that began in the morning that cause rise to the research road segment.

For the execution is done for three (3) days, as follows:

1. Monday, assumed that day represents another working day (Monday to Friday).
2. Saturday, assumed as a government worker's day-off.
3. Sunday, assumed as a day off when all government and private institutions and schools do not perform activities.

The types of vehicles to be surveyed in this study, as follows:

1. Light Vehicle (LV) is light vehicle, like passenger car (sedan, jeep, urban transportation, minibuss, and pickup truck).
2. High Vehicle (HV) is a heavy vehicle, ie truck, tank car, bus and trailer.
3. Motor Cycle (MC) is motorcycle and auto rickshaw.
4. Un Motor Cycle (UM) is a non-motorized vehicle, ie bicycle, pedicab, and cart.

2. Vehicle Speed Survey

In this survey, there are 3 (three) classifications used in obtaining traffic speed data, as follows:

- Spot Speed
The speed of the vehicle at a time when the vehicle crosses two specified points whose distance has been determined. In this survey the distance between two specified points is relatively short.
- Journey Speed
The average speed of a vehicle between the first point to the second point can be determined from the distance divided by the total journey time.
- Running Speed
The average speed of a vehicle that passes at a certain distance in the condition of the vehicle is still running, such as a condition where the speed is reduced by the time barriers that occur.

3. Roadside Barriers Survey

Survey conducted in this study is a journey speed survey of vehicles. Surveys were conducted to obtain journey time on the road segment which will then be converted into speed data with the help of segment length data being reviewed. The vehicles surveyed were, private vehicles, public transport, buses, and trucks. Survei Hambatan Sampling

Surveys of roadside barriers are carried out for the types of roadside barriers such as parking or stopping vehicles, slow and non-motorized vehicles, in and out vehicles, pedestrians' zone. Data collection and recording of roadside barriers are conducted along 200 m around the location of the observation point / survey. The roadside barriers data becomes the material in the process of calculating the capacity of the road segment.

b. Secondary Data

Secondary data collection is done to several agencies to obtain data related to research studies. Required data are road geometric data, population number, and traffic characteristic. For related agencies are Development Planning Agency at Sub-National Level, Central Statistics Agency, Public Works Department and Spatial and Transportation Department.

B. DATA ANALYSIS METHOD

The method of analysis used in the study is as follows:

1. Capacity, influenced by road width, roadway limit, medians of divided highway, city size and roadside barriers, by using MKJI, 1997.
2. Level of service of traffic based on the ratio of traffic volume with capacity (VCR), and speed, using MKJI, 1997 and graph of service level relationship with VCR and speed.

The several stages of data analysis conducted in the study, as follows:

- a. To identify traffic characteristics of each road segment;
- b. To calculate roadside barriers from each road segment based on the number of slow, stop, and parking vehicles also pedestrians zone;
- c. To analyze the level of service based on vehicle capacity and speed;

V. RESULTS AND DISCUSSION

A. LEVEL OF SERVICE ANALYSIS

The capability of a road in the flow of traffic, is an assessment of the level of service. In assessing the level of service, calculations are done with two aspects. Comparison between the volume with the capacity and the speed aspects of the vehicle on a road segment is a considerable aspect.

Tamin [2], mentions that there are two definitions of service level of a road segment that need to be understood, such as the level of service depending on traffic flow and the level of service would be depending on the volume. The level of service (depending on traffic performance) relates to the speed or density, which depends on the ratio between flow and capacity of the traffic, has six service levels of A-F. The next level of service (depending on the volume) depends on the type of infrastructure not the traffic flow, the highway has a high level of volume while the narrow road has a low level of volume.

A road is said to have a problem if the ratio between volume and capacity has been close to one, evident from the unstable traffic. At the weekend, the top speed of the five roads took place on the Soekarno Hatta street during the day at a speed of 54.83 km / h and the lowest speed occurred on the Yos Sudarso street in the afternoon with a speed of 26.22 km / h. Each road segment has a vehicle speed that is very less than the standard speed as Arterial Road (≥ 60 km / h).

- a. On holidays, the top speed of the five roads took place on the Soekarno Hatta street in the morning at a speed of 63.84 km / h and the lowest speed occurred on the Yos Sudarso street in the afternoon with a speed of 29.24 km / h. Almost all road segments have a vehicle speed that is less than the standard speed as Arterial Road (≥ 60 km / h), except on Soekarno Hatta street in the morning.
- b. On weekdays, the top speed of the five roads took place on the Soekarno Hatta street in the morning at a speed of 52.27 km / h and the lowest speed occurred on the SM Raja street at noon with a speed of 25.23 km / hour. Each road segment has a vehicle speed that is very less than the standard speed as Arterial Road (≥ 60 km / h).

From comparison of VCR with speed can be known the category level of service according to existing condition on primary arterial road network, as follows:

- 1) **Yos Sudarso Street**, level of service category, weekends, holidays and working days, are generally located in D and E category. Traffic is in the category C in the morning, only on public holidays. This indicates that the flow is unstable, low and have varying speeds, and traffic volume is close to capacity.
- 2) **HM. Yamin Street**, the category level of service for the weekend, holiday and working days, is generally in the category of C, only on holidays morning, the level of service is in Category B. This indicates that the flow is stable and the speed can be controlled by traffic.
- 3) **Imam Bonjol Street**, the category level of service for weekends, holidays and working days, generally during the day and afternoon are in the category of C, only in the morning of category B. This indicates that traffic flow is stable and the speed can be controlled by traffic.
- 4) **Soekarno Hatta Street**, the category level of service for weekends, holidays and working days, generally in the morning and afternoon is in the category B, only in the afternoon that is in category C. This indicates that the current is stable, the speed is slightly limited by traffic, and the driver can still be free in choosing his speed.
- 5) **SM Raja Street**, the category level of service for weekends, holidays and weekdays, is generally in the morning and afternoon in the category of C, some of which are in categories D and E. This indicates that the flow is stable and the speed can be controlled by traffic.
- 6) **Gatot Subroto Street**, the category level of service for weekends, holidays and working days, generally in the morning and afternoon are in the category of C, some are in category D. This indicates that the traffic flow is stable and the speed can be controlled by the traffic.

The results of the analysis indicate that the level of service in general on both public holidays and working days at peak hours is in the category of C (some roads are in D and E). The grade C describes a stable flow condition, but the speed and motion of the vehicle are controlled, the volume used for urban road design.

In the Wijayanto Y study [7], it states that the level of service is said to be free flow if the capacity is greater than the volume of traffic at peak hour and vice versa. And with the lower level of service a road indicates that there will be a serious delay/congestion.

In relation to the results of the analysis and calculation when compared to the determination of the level of service desired for the arterial road, based on Regulation of the Minister of Transportation of the Republic of Indonesia No. 96 of the Year 2015 on the Implementation of Management Activities and Traffic Engineering Manual should be for the primary arterial road, the level of service is at least at the grade B.

In this regard, in the Revised Local Transportation Rate (Tatralok) of Tebing Tinggi City 2014, the analysis shows that the level of service is generally in category B. This indicates that within 3 (three) years, the volume traffic and roadside barriers on the primary arterial road (location of observation) increased significantly, so capacity and level of service (LOS) on primary arterial road in Tebing Tinggi city also experienced a significant decrease as well.

In line with this, that on the national spatial plan and the draft regulation of the City of Tebing Tinggi is a regional activity center on the National Urban System of Tebing Tinggi City with the functions of trade and services, the role of Tebing Tinggi city will become increasingly important as regional trade and service ties, especially with the development of infrastructure (roads) from and to KSN Mebidangro, KSN Lake Toba, SEZ Mangke Seaport and Kuala Tanjung Port, will have a major impact for economic growth and development of Tebing Tinggi City especially in trade and services sector.

With the development of the center of economic growth that will increase the volume of traffic in the City of Tebing Tinggi as the East Cross and Middle Cross. Besides, traffic on primary arterial road in Tebing Tinggi city is mixed with local traffic, so roadside barrier is in high category. These conditions will affect the decrease in capacity and level of service (LOS) on primary arterial road in Tebing Tinggi city, and this will also have an adverse effect on economic activity in Tebing Tinggi City, so the capacity of primary arterial road needs to be improved, to support the traffic of Tebing Tinggi city which functions as a regional activity center.

VI. CONCLUSION AND RECOMMENDATION

A. CONCLUSION

Based on the results of the analysis and discussion conducted and considering the relation with the formulation of the problem and research objectives it can be concluded as follows:

1. Roadside barriers on the primary arterial road network in Tebing Tinggi city cause a decrease in capacity. which is quite significant, the highest decrease occurred on Yos Sudarso street of 1758, 91 smp / hour and the lowest on Imam Bonjol street of 1123, 37 smp / hour.
2. Infrastructure development (roads) at KSN Mebidangro, KSN Lake Toba, KEK Sei Mangke and Kuala Tanjung Port will have a decrease in the level of service on the primary arterial road in Tebing Tinggi city. Where the development of the KSN will increase traffic volume, whereas the existing condition of the analysis shows that the level of service is generally on holidays and working days in peak hours are in the category of C (some roads are in the category D and E), so that if not followed by capacity and road infrastructure improvements, existing roads can not accommodate the number of vehicles.

B. SUGGESTION

1. Tebing Tinggi Municipal Government is expected to increase capacity by eliminating roadside barriers along primary arterial roads, by making policies on banning parking activities on both sides of the road, prohibiting vehicles from slowly entering primary arterial roads, arranging public transport stops, and activate the sidewalk function and create a pedestrian zone.
2. Tebing Tinggi Government is expected to soon develop the primary arterial road network through the construction of ring road, to anticipate the increase of traffic volume.

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