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Performance Analysis of Malino Road Segment In Gowa Regency of South Sulawesi Province

Cita Elmika[1], Shirly Wunas[2], Jamaluddin Rahim[3]
[1] *Master Degree of Transportation Planning, Faculty of Postgraduate, Hasanuddin University,*
[2]*Professor, Urban and Regional Planning, Hasanuddin University, Makassar-Indonesia*
[3]*Lecturer, Transportation Engineering, Hasanuddin University, Makassar-Indonesia*

ABSTRACT
These discussions aim to explain; 1) traffic behavior condition in Malino road segment, 2) performance of service function of primary collector road network of Malino segment in the framework of development of National Transportation System, and 3) handling strategy to improve road transport performance of Malino. The road network discussed is the Sungguminasa-Malino road segment distinguished segments of high density buildings and low density building segments. Data were obtained from traffic surveys and direct interviews of respondents related to road transport handling. The methods used by quantitative and qualitative analysis include behavioral traffic analysis, traffic growth and SWOT analysis. The results showed that the high-density road has a degree of saturation of 0.42 at the level of category "B" road service, indicating that traffic behavior in the segment is stable traffic flow with medium traffic volume and speed of 40.95 km/hour. Low-density road segment has a degree of saturation of 0.28 at the level of category "A" road service, indicating that traffic behavior in the segment is free flow, low traffic volume with field speed 42.03 km/hour. Traffic growth shows in 2026 road capacity with critical condition. Performance road service based on National Transport System indicator, index of survival is 0.00011, meaning that every 10.000 soul of population there is 1 accident. Accessibility index has not fulfill minimum road service standard (2,27 to 3,12). Index of road capacity is adequate and efficient use. Strategies to improve road network services are traffic management, improving public transport and increasing road capacity.
Keywords: *Degree of Saturation, Road Performance, SWOT*

I. INTRODUCTION

The buffer zone of the city is an area adjacent to the urban outer circumference [1]. Geographical location of Gowa Regency as the gateway of Southern part of Makassar City is the main buffer of Makassar City. As a buffered city required resources of labor and raw materials or goods [2]. Gowa regency distributes C quarry mining the surrounding area because the area is passed by Jeneberang River. The development of road infrastructure can encourage the smooth flow of goods of the marketing area which in turn can encourage a more competitive market mechanism [3]. Transportation infrastructure requires the integration of development in order to generate public economy and make the transportation sector plays an important role the development and growth of other sectors [4].

Malino road segment is under the authority of the Highways Department and Construction of South Sulawesi Province. The road is a collector road in the primary road network system that connects between Gowa and Sinjai Regency. Malino road segment becomes the main access to serve strategic areas such as education area for Engineering Faculty of Hasanuddin Univerity and strategic area that is being planned by Gowa Regency Government that is Malino Botanical Garden. Mining activities in the road segment is also increasing as Gowa Regency becomes the main supplier of Makassar City. In addition Sungguminasa City also becomes part of the Mamminasata program, which is directed as a buffer area of Makassar City, especially services, trade and settlements. The interaction between the land use system and the road network system leads to an increase in traffic volume.

Based on these problems, it is necessary to study the traffic behavior condition in Malino road segment, the service performance of the road network function in the framework of the development of National Transportation System (NTS) and discuss the handling strategy in improving the performance of Malino road segment transportation.

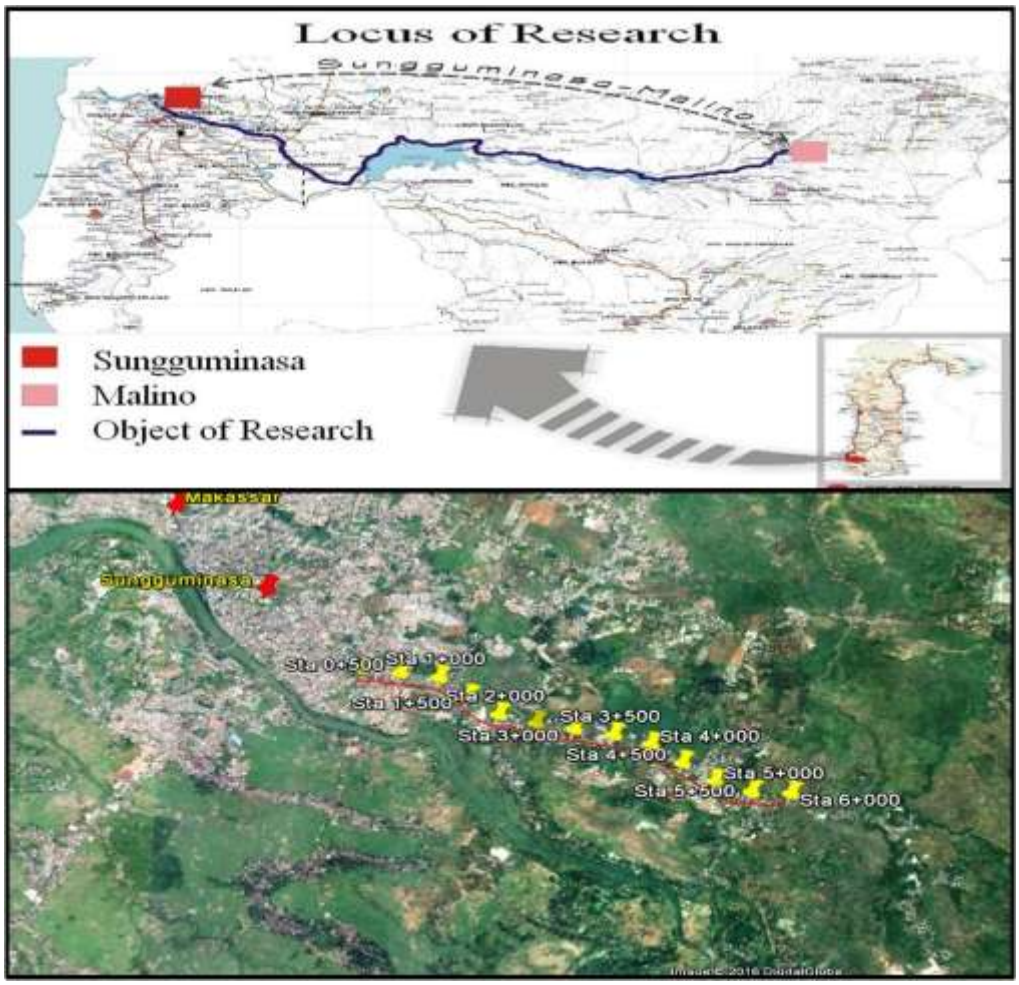

Figure1. Locus of research

II. METDHOLOGY

This research was conducted on the primary collector road network of the Malino axis segment (Sungguminasa-Malino) is divided into 2 segments for the analysis as shown in Figure 1. Segment 1 road network in Somba Opu District and segment 2 of road network in Bontomarannu District.

This research uses qualitative and quantitative approach by analyzing traffic behavior, traffic growth and handling strategy in improving performance of Malino road segment. Quantitative approach by utilizing traffic volume and road condition is the road geometry and road construction conditions in order to study traffic behavior and service performance of primary collector road network in Malino Axis. Qualitative approach is descriptive description using data and interview results to formulate handling strategy in improving performance on Malino axis road.

The unit of analysis is: (i) Malino road segment, which serves traffic in Somba Opu District and Bontomarannu District, (ii) Traffic flow on 2 segments of road network conducted traffic observation and traffic on Monday 19th December 2016, Thursday 22nd December 2016 and Saturday 24th December 2016 at 06.00 am to 18.00 pm.

The data used are data obtained by conducting traffic volume calculation survey, geometric observation of road and vehicle speed in accordance with traffic enumeration technical guidelines (Department of Settlement and Regional Infrastructure, 2004). Documentation data obtained from Central Bureau of Statistics of South Sulawesi Province, Central Bureau of Statistics of Gowa Regency, Department of Highways and Construction of South Sulawesi Province, Public Works Office of Gowa Regency and Gowa Resort Police, Spatial Plan of Gowa Regency (2012-2032), Spatial Plan of South Sulawesi Provincial in Year 2009-2029, traffic accident report in Year 2015-2016, road infrastructure data, population data and vehicles.

Traffic behavior on the road includes capacity, travel time and average travel speed [5]. The capacity of a segment is the maximum number of vehicles passing through the road (in one or two directions) within a specified time period [6]. The travel speed is the average speed of the traffic calculation based on the length of the road segment divided by the travel time of the vehicle. While the travel time is the total time required to pass a certain path length.

The degree of saturation is a quantitative measure of traffic behavior that indicates the level of road service. Level of service road can be determined through the value of VC ratio (VCR) which is the ratio between the volumes of vehicles through the road segment in a certain time range. The greater the value of the comparison then the level of road service will get worse and affect the speed of vehicle operations. Future road service levels are derived from upcoming traffic volumes compared to road capacity. Future traffic volume is obtained from the result of traffic volume projections, number of vehicles and population [7]. Population growth analysis was conducted to determine the growth rate of long-term traffic flow [8].

Regulation of the Minister of Transportation No.KM.49/2005 on National Transportation System, in realizing the implementation of effective and efficient transportation can be analyzed from 14 performance indicators. This discussion covers 4 indicators for road network analysis: safety, accessibility, capacity and efficiency of road used. Measurement of road network performance uses accessibility index in accordance with Minimum Service Standards (MSS) Department of Public Works [9]. Based on the Decree of Minister of Settlement and Regional Infrastructure No. 534/KPTS/M/2001, the accessibility index is the proportion of available road length wide. Capacity indicator is the capacity of the transportation infrastructure network assessed by traffic volume, speed, basic capacity of road, degree of saturation, and levels of road service. Efficient indicators are the realization of the use of road infrastructure networks to their capacities.

Future traffic performance is derived from future traffic volumes compared to road capacity [7]. Population growth analysis was conducted to determine the growth rate of long-term traffic flow [8]. SWOT analysis to compare between external factors and internal factors. External factors consist of opportunities and threats, while internal factors consist of strengths and weaknesses [10]. SWOT analysis is used to formulate strategies for handling performance improvement of Malino road segments.

III. RESULTS AND DISCUSSION

Traffic behavior

Traffic behavior is shown in Table 1. The peak traffic volume in Segment 1 is 1,106 pcu/hour with road capacity is 2,652 pcu/hour. The VCR value of 0.42 indicates that road service levels are in category B, meaning that traffic flow is stable with medium traffic volume and speed 42 km/hour. While in Segment 2 the peak traffic volume is 785 pcu/hour with road capacity is 2,821 pcu/hour, it is obtained VCR value is 0.28 indicating road service level is in category A means free flow condition with low traffic volume and speed 48 km/hour.

Table 1. Traffic Behavior of Malino Axis Road

No.	Segment	Volume (pcu/hour)	Capacity (pcu/hour)	Degree of Saturation	Speed (km/hour)	Travelling Time (seconds)	Level of Service
1.	Segment 1	1.106	2.652	0,42	42	42,86	B
2.	Segment 2	785	2.821	0,28	48	37,50	A

Sources: Results of the analysis, 2017

This research shows several things, namely: traffic behavior includes degree of saturation, speed and travel time (11). Service performance of road network function is needed to know the amount of value generated by the availability of infrastructure and transportation facilities available. KM.49 Year 2005 on Nation Transportation System, in realizing the implementation of effective and efficient transportation requires performance indicators. Performance indicators are congratulations, accessibility, sufficient capacity, and efficiency.

The peak traffic volume of the Malino road segment is on Saturdays, it happens because along this road corridor serves several tourist destinations such as: Malino Flower City, Culinary Tour and Bili-Bili Lake Landscape, Fishing Tour and Dewi Sri Garden. In addition to serving local traffic activities, Malino axis road links also serve regional traffic. Peak traffic volume on weekdays from Monday to Thursday undergoes a significant change over the 16.00-17.00 pm periods, indicating local traffic activity such as returning home and spill-over market activity in the late afternoon which is the cause of vehicle buildup. The movement of traffic volume during rush hour with existing road capacity can serve the movement of vehicles so that the capacity of transportation infrastructure is sufficiently available. Very high population densities of 5,605 people/km^2 based on Ministerial Decisions of Settlement and Regional Infrastructure No.534/KPTS/M/2001 (5000 inhabitants/km^2) indicate that the community has not gained, easy accessibility to reach the whole region. The low average vehicle speed of 37.62 km/hour occurred on Saturday 15:00 pm to 18:00 pm, while according to Government Regulations No.34 of 2006 on the road that the primary collector roads serve vehicles with a speed of at least 40 km/hour. This is influenced by the width of the road 6 meters, so there is no room for the vehicle to preceded.

The number of motor vehicles continues to increase with the average rate of vehicle growth in 2026 is predicted to be 26.41%, where the service level of the Malino road segment is in category "E" with a degree of saturation of 0.97 for solid density space and in density space The building is in category "C" with the value of degree of saturation 0.65. According to IHCM, the maximum permissible saturation level is 0.75; it is preferable to plan alternative solutions if the capacity of the road approaches the existing capacity. The intermodal integration in road transport that has not been effective has resulted in some people prefer the mode of motorcycle mode [12]. Based on the results of the strategy analysis of handling in improving the performance of the Malino road segment is as follows: (i) traffic management (ii) limiting vehicle tonnage in accordance with road class (iii) improving public transport.

Table 2. Road Service Performance

No.	Transport Performance Indicators	Road Network Performance	Roads	
			Segment A	Segment B
1.	Safety	Number of accidents on the number of population per year	Die 3 people, seriously injured 5 people and slightly injured 25 people with the number of population at research location 191,901 souls so that obtained index value survived 0.00011	
2.	Accessibility	The length of the traffic space to the total area	Accessibility = 3.12 (Not yet fulfill MSS road)	Accessibility = 2.27 (Fulfill MSS road)
			Road surface conditions: either 81%, moderate 8%, lightly damaged 6%, heavily damaged 5%s	Road surface conditions: either 38%, moderate 5%, minor damage 2%, severe damage 55%
3.	Capacity	Transportation infrastructure network capacity is sufficient to fulfill the demand of service users	Basic capacity condition 2/2 UD = 3100 pcu/hour Road wide correction factor 6 meters = 0.91 The unbalanced correction factor = 1 Side correction factor side barrier = 0.94 Actual capacity = 2.652 pcu/hour	Basic capacity condition 2/2 UD = 3100 pcu/hour Road wide correction factor 6 meters = 0.91 The unbalanced correction factor = 1 The factor of low side barrier correction = 0.94 Actual capacity = 2.821 pcu/hour
4.	Efficient	Actual use of infrastructure network	Efficiency = 58.31% User network infrastructure against	Efficiency = 72.16% User network infrastructure against

Source: Results of the analysis, 2017

Road sides handling strategy

Table 3 shows the SWOT analysis matrix. The SWOT analysis matrix indicates that the strengths include: (i) strategic location (ii) many potential areas (iii) the level of road service is below the maximum standard IHCM (iv) high population density (v) serving local traffic and mixed traffic. The weaknesses are: (i) class III road with MST is 8 tons, (ii) weigh bridge, (iii) low field speed, (iv) accident prone (v) unsteady road conditions. Opportunities include: (i) Law no. 38 of 2004 on roads (ii) Law no.22 year 2009 on traffic and road transport (iii) Government Regulation No. 33/M-IND/PER/7/2013 concerning Low Cost and Green Car (iv) Mamminasata Regional Spatial Plan (v) The interest of private sectors to increase business field and labor. Threats include: (i) Increasing population (ii) Private vehicle ownership increases (iii) Heavy trajectory of vehicles (iv) Limited government budget (v) credit and down payment (DP) of light motor vehicles.

Table 3. Matrix of SWOT Analysis

Internal Factor / External Factor	**Strength (S)** - The location is strategic - Potential area - The level of road service is below the maximum standard of IHCM - High population density - Serving local traffic and mixed traffic.	**Weakness (W)** - Class III road with MST <8 tons - Weigh stations are not working - There is no limitation of vehicle loading - Accident prone - Unsteady road conditions
Opportunity (O) - Law no. 38 of 2004 and Government Regulation no. 34 of 2006 on the road - Law no. 22 about traffic and road transport - Regulation of the Industrial Government No. 33/M-IND/PER/7/2013 concerning LCGC - Mamminasata Regional Spatial Plan - Private investors	**SO Strategy:** - Arrange land use in accordance with Regional Spatial Plans - Implementing taxation system each vehicle - Controlling new buildings that may cause side barriers.	**WO Strategy:** - Add vehicle boundary restrictions - Conducting reconstruction on heavily damaged roads - Returns the primary collector path function - Create alternative lines for heavy vehicles
Threat (T) - The population continues to increase - Ownership of private vehicles more and more - Track trajectory of quarry mining C - Limited government budget - Education Area	**ST Strategy:** - Traffic management - Limiting the tonnage according to the road class - Improve decent public transport - Increased road capacity	**WT Strategy:** - Operate weigh stations as a means of weight control and truckloads - Perform routine maintenance on damaged roads - Make sidewalks

The number of motor vehicles continues to increase with the average rate of vehicle growth in 2026 is predicted to be 26.41% where the service level of the Malino road segment is in category "E" with a degree of saturation of 0.97 for solid density space and at building density space was in category "C" with a degree of saturation of 0.65. According to IHCM, the maximum permissible saturation level is 0.75 then it is better to plan alternative solutions if the demand capacity approaches the supply capacity. The intermodal integration in road transport that has not been effective has resulted in some people prefer the type of motorcycle mode to transport [12].
Based on the results of the strategy analysis of handling in improving the performance of the Malino axis road is as follows: (i) traffic management (ii) limiting vehicle tonnage in accordance with road class (iii) improving public transport.

IV. CONCLUSION

Traffic behavior of Malino axis road segment is at low saturation level (0.28-0.42). Average field vehicle speed is 38.51 km/hour which is not suitable with minimum speed for primary collector roads. The level of road service of Malino axis in the high building space is in category "B" in the sense of medium traffic volume so that it has limitation to choose the vehicle while in medium density space the traffic volume is low with category road service level "A". Projection of traffic growth next 10 years predicted is at the level of category "C" service so it is necessary to control the traffic space, control the road changes along with the increase of road capacity, to install the accident-prone signs. Develop an activity program that can accommodate the entire transportation needs so that the implementation of transportation with sufficient capacity, smoothly and safely in realizing the National Transportation System effective and efficient.

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