

The Saturation Degree of Road Segments between Pitu Riase Subdistrict and Pangkajene Sidrap Regency

A. R. Syahputra^{1*}, B. Hamzah², and M. Y. Jinca³

¹Transportation Planning Study Program, Hasanuddin University, Makassar, Indonesia

²Department of Architecture, Hasanuddin University, Makassar, Indonesia

³Department of Urban and Regional Development, Hasanuddin University, Makassar, Indonesia

E-mail*: andirezasyahputra@gmail.com

ABSTRACT

This research aimed to analyze the degree of saturation (DS) of the road segments between Pitu Riase Subdistrict and Pangkajene, the capital of Sidenreng Rappang (Sidrap) Regency, and to explain the policy of the development and construction of the local transportation road segments of Pitu Riase Subdistrict. The research was conducted using survey techniques and direct interviews with the respondents who were directly related to the handling of road transportation. The research result indicated that the saturation degree of the primary arterial road segments of Pangkajene-Empagae and Lancirang-Tanrutedong had reached 0.77 and 0.54 with the service level of C and B, respectively. Meanwhile, in the local roads, the highest saturation degree was in the road segment of Sarawatu-Bilariawa with the value of 0.21, and the lowest saturation degree was in the road segment of Barukku-Compong with the value of 0.07, which was categorized as A level. The traffic growth showed the critical point of the capacity development of the local road for the growth of 2% at the road segment of Sarawatu-Bilariawa would occur in 2024. The development strategy of the local roads was to increase the budget allocation for the road maintenance, to add markers for the limitation of the vehicle loads, and to reconstruct the heavily damaged parts of the roads.

Keywords: *Level of saturation; performance; local road; service level.*

1. INTRODUCTION

Transportation is defined as the movement of people or goods from the place of origin to the destination and facilities used for that purpose [1]. Human or goods transport is not usually an end goal, but it is done to achieve other goals [2]. Transportation serves as a sector of development support (the promotional sector) and service providers (the servicing sector) for regional and economic development. Thus, transportation as a regional infrastructure has a function associated with the development of the region and facilitate the economic wheel of the community in order to achieve the goal of improving people's welfare. The level of

service is strongly influenced by the capacity and flow of traffic. The continuous addition of road infrastructure is difficult to implement due to a large number of funds and the limited land available [3].

Transportation service system in Sidrap Regency is mainly served by road transportation. Transportation infrastructure requires the integration of development in order to generate economy of public and make the transportation sector plays an important role in the development and growth of other sectors [4]. Pitu Riase Subdistrict is the farthest Subdistrict from Pangkajene, the capital of Sidrap Regency. This subdistrict is served by

highway transportation with a local road hierarchy. This road is the only way where people go in and out of Pitu Riase Subdistrict. In Pitu Riase Subdistrict, there is a class C quarry mine that serves Sidrap and Wajo Regencies which causes the high activity of trucks loaded mining materials. There is also a Puncak Nature Tourism Park and the investment of cattle farms of PT. Berdikari United Livestock (BULI) that support the local community's economy. Previous research on the performance of the road network between the capitals of Kecamatan Maritenggae-Panca Rijang-Watang Pulu shows that the development strategies were by developing road network, public transportation arrangement and safety equipment for general road users [5].

The connecting road between Pangkajene, the capital of Sidrap and Pitu Riase Subdistrict in the future will experience growth in movement and traffic volume so that it can affect the capacity of existing roads at present. The rapid movement of traffic caused the need for analysis related to the saturation level of the roads in Sidrap Regency, especially in the arterial roads and local roads leading to Pitu Riase Subdistrict. The integration of inter-modal in road transport that has not been effective. This resulted in some people prefer the type of motorcycle mode to transport [6]. The limitation of development budget and handling of road transportation requires a change of mindset towards planning and determining development and development of

road transport effectively and efficiently. The value of the saturation level and road service level parameters need to be gathered [7].

The condition of the entire arterial road segment is coated with hot mix asphalt surface in good condition with two-lane type without a separator (2/2 UD). The local condition of sites are, there is no drainage on both sides of the road, but on the right side of the road, there is a secondary irrigation field that serves to drain the water to the rice fields. The need for road drainage channels to smooth surface water flow and prevent puddles [8].

In order to get more detailed analysis about the performance of arterial and local roads between the Pitu Riase Subdistrict and the capital of Sidrap Regency, it is necessary to study of the level of traffic saturation, traffic growth, and strategy of increasing primary arterial and local roads.

2. METHODOLOGY

A. Research Location

This research is descriptive research, which using qualitative and quantitative approach by analyzing the saturation level of the road segment, traffic growth and policy strategy of development and development of local road transportation to solve the problem. The location of the research is the Pangkajene-Tanrutedong primary arterial road which is divided into two research sites, and the local road segment is divided into four research sites, as presented in Fig. 1.

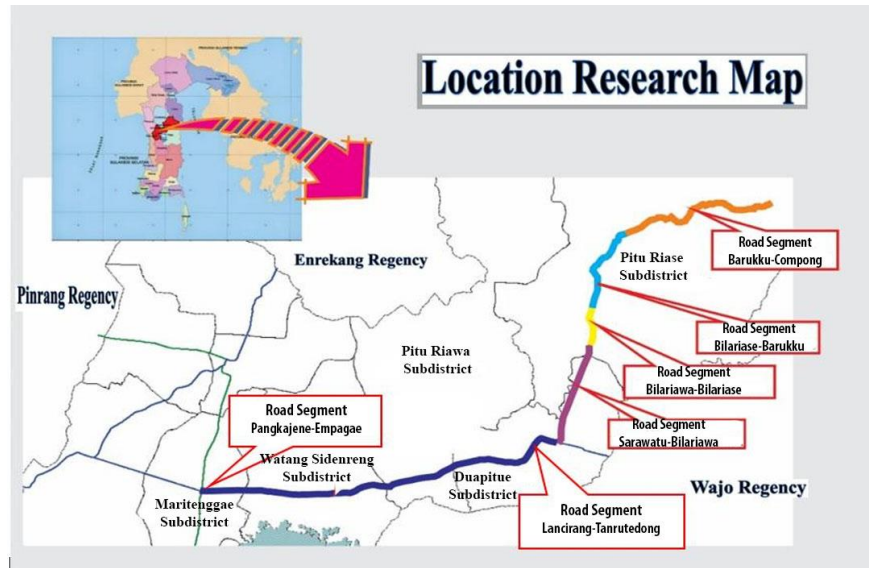


Fig. 1. Research sites based on the road segment locations

B. Design and Research Variables

A data analysis technique used in this research is with qualitative and quantitative analysis. Qualitative analysis is a descriptive description of each parameter based on related theory and obtained, while quantitative analysis is the result of a survey that can be calculated mathematically.

B.1. Population and Sample

The research populations spread from Pangkajene to Pitu Riase which includes two arterial and four local road segments. They are (i) Pangkajene-Empagae and Lancrang-Tanrutedong road segments of primary arterial road and (ii) Sarawatu-Bilariawa, Bilariawa-Bilariase, Bilariase-Barukku and Barukku-Compong roads for local roads. The sample of traffic flow data was taken on each of the road segments studied from Wednesday, January 4, 2017 to Tuesday, January 10, 2017, during daytime from 7 am to 6 pm.

B.2. Method of collecting data

The data used are primary and secondary data. Primary data were obtained by conducting a traffic flow survey by counting the number of vehicles of various types passing through a road segment, as per the traffic enumeration technical guidelines [9] and measuring the condition of the roads studied. Secondary data in the form of documents and references that are considered appropriate to the problem under study.

B.3. Data analysis method

Analysis of road geometric condition for traffic using the procedure of geometric planning of out-of-town road [10]. The calculation of road capacity is done by direct measurement of road in the research location and using the basic equation in Manual of Road Capacity of Indonesia (MKJI 1997) [11] for the capacity of out-of-town road segments.

Analysis of the saturation level of traffic using a comparison analysis between traffic

volume and the capacity of road segments [2]. Capacity is the maximum number of vehicles that have sufficient possibilities to pass through the road [12]. Level of saturation is a quantitative measure of traffic behavior which, when qualitative, will indicate the level of road service to traffic. The service level indicator of a road segment is the overall condition of the road segment [13]. Road capacity can be identified by Directorate General of Highways [11]:

$$C = C_o \times FC_w \times FC_{SP} \times FC_{SF} \quad (1)$$

where

C = Capacity (pcu/hour)

C_o = Basic Capacity (pcu/hour)

FC_w = Factor of road width adjustment

FC_{SP} = The direction separation adjustment factor

FC_{SF} = Side and side shoulder adjustment factors

The traffic volume is calculated from the multiplication of the amount of traffic on each vehicle type with the vehicle conversion factor influenced by the slope of the road and the road direction division. Each type of vehicle has different movement characteristics because of the dimensions, speed, and maneuverability of the road geometric. Therefore the conversion of passenger car units is used [14].

Accessibility is measured by the criteria of comparison of road length to the area served then juxtaposed with Minimum Service Standards (MSS) road as stated in Decree of Minister of Settlement and Regional Infrastructure [15]. Accessibility means ease of

moving between two places [16]. Future road service levels are derived from future traffic volumes compared to road capacity. Future traffic volume is derived from current traffic volumes, the number of vehicles and population [17].

$$Q_i^* = F_i \times Q_i \quad (2)$$

where:

Q_i^* = Traffic volume in the future (pcu/hour)

Q_i = Traffic volume now (pcu/hour)

F_i = Growth factor

$$F_i = \left(\frac{I'}{I}\right) \times \left(\frac{M'}{M}\right) \times \left(\frac{U'}{U}\right) \quad (3)$$

$\frac{I'}{I}$ = the ratio of the population in the future and now

$\frac{M'}{M}$ = the ratio of traffic volumes in the future and now

$\frac{U'}{U}$ = the ratio of vehicle used in the future and now

Analysis of population growth was done to determine the growth rate of long-term traffic flow [18]. The Strength, Weakness, Opportunity, and Threat (SWOT) is the analysis to compare between external factors and internal factors. External factors consist of opportunities and threats, while the internal factors consist of strengths and weaknesses [19]. SWOT analysis is used to formulate the policy strategy of development and development of local road transportation in Pitu Riase Subdistrict.

3. RESULT AND DISCUSSION

A. Degree of Saturation (SD)

The saturation level of the road segment can be seen in Table 1. The volume of traffic flow passing through the Pangkajene-Empagae road at peak hour is 2,024 pcu/hour, while the volume of traffic passing through the Lancirang-Tanrutedong road at peak hour is 1,420 pcu/hour. With the capacity of the arterial road about 2,624 pcu/hour, the saturation level of each road segment is 0.77 and 0.54 and the service level of C and B. The capacity of the road segment of each local road is Sarawatu-

Bilariawa segment of 2,842 pcu/hour, Bilariawa-Bilariase road capacity of 1,946 pcu/hour, Bilariase-Barukku and Barukku-Compong road capacity of 2,032 pcu/hour. The value of the saturation level of the four research sites ranged from 0.07-0.21 so that the condition of the road service level was included in category A level. Pitu Riase Subdistrict accessibility index was 0.31, and the mobility index was 11.88, so it has fulfilled the road service standard as stated in the Decree of Minister of Settlement and Regional Infrastructure No. 534 / KPTS/M/2001 [15].

Table 1. Road Saturation Level between Pitu Riase Subdistrict and Pangkajene

No.	Roads	Traffic volume (pcu/hour)	Capacity (pcu/hour)	Saturation Rate	Service Level
Primary artery roads					
1.	Pangkajene-Empagae	2,024	2,624	0.77	C
2.	Lancirang-Tanrutedong	1,420	, 624	0.54	B
Local roads					
1.	Sarawatu-Bilariawa	532	2,842	0.21	A
2.	Bilariawa-Bilariase	305	1,946	0.16	A
3.	Bilariase-Barukku	202	2,032	0.10	A
4.	Barukku-Compong	135	2,032	0.07	A

Prediction of traffic volume growth and long-term saturation degree (10 years) in Table 2. The volume of primary arterial road traffic in 2019 is 3,080 pcu/hour with the assumption of fixed road capacity, then the degree of saturation indicates a value of 1.12, while the volume of local road traffics in 2025 of 2,855

with the assumption of fixed road capacity then the degree of saturation (DS) shows the value of 1.13. The 3.5% growth assumption by the Decree of Director General of Highways in 2012 for rural roads indicates the level of F service in the year.

Table 2. Growth rate of primary arterial road traffic volume and local road growth assumption 3.5%

No.	Year	Roads			
		Primary Arterial Road		Local Road	
		Volume (pcu/hour)	DS	Volume (pcu/hour)	DS
2017	0	2,024	0.77	532	0.21
2018	1	2,497	0.95	656	0.26
2019	2	3,080	1.17	810	0.32
2020	3	3,800	1.45	999	0.39
2021	4	4,688	1.78	1,232	0.49
2022	5	5,784	2.20	1,520	0.60
2023	6	7,136	2.71	1,876	0.74
2024	7	8,803	3.35	2,314	0.91
2025	8	10,860	4.13	2,855	1.13
2026	9	13,398	5.10	3,522	1.39
2027	10	16,529	6.29	4,344	1.71

B. Road Development Strategy

The SWOT analysis matrix in Table 3 indicates that the strengths include: (i) population density along the road segment is still relatively low, (ii) access to the Puncak Bila natural area, (iii) potential investment in PT. BULL, (iv) flat road type, (v) good concrete road surface. The disadvantages are: (i) no road drainage, (ii) no vehicle limitation, (iii) land use pattern of settlement elongated along the road. Opportunities include: (i) as the main route connecting Pitu Riase Subdistrict to other regions; (ii) road improvement plan refers to Spatial Plans of Sidrap Regency; (iii) tourism development plan. Threats include: (i) limited local government budgets, (ii) population and vehicles increasing annually.

This research indicates that there are several aspects that influence the saturation level of the road segments, which is an indicator of road capacity in MKJI [11]. Road capacity is influenced by several factors, namely capacity adjustment factor due to directional division, capacity adjustment factor for road width and

capacity adjustment factor due to side barrier. The largest traffic volume of the Pangkajene-Empagae road segment occurred on the morning of Wednesday, this is because the road segment is a provincial road linking Sidrap and Wajo regency. The most crowded market day in Pangkajene City occurred on Wednesday. Regular motorcycle movements, intercity transport vehicles, and trucks of freight and private vehicles travel in the morning. The social facilities are available in Pangkajene City i.e. hospitals, schools, government and private offices, markets, recreational sports venues, trading centers and densely populated settlements causing high traffic activity. The traffic volume of the densest local road segment is on the Sarawatu-Bilariawa streets. During the seven-day survey, the peak hour time occurred on Sunday in the afternoon. This is because the road is an entrance to Pitu Riase Subdistrict. The high level of traffic activity is because in the afternoon many trucks carrying materials are in and out to pick up the existing class C quarry mine in Bila village. Also, this road

segment is the only road to the Natural Tourism Park Puncak Bila that located in Pitu Riase Subdistrict.

Based on the Minimum Service Standards of Regional Infrastructure (Decree of the Minister of Settlement and Regional Infrastructure, 2001) [15], accessibility index is 0.31, and the population density is about 26 people/km² (< 100 people/km²) so that it has qualified MSS accessibility > 0.005. The volume of traffics at peak hour compared to

road capacity to obtain the degree of saturation. The degree of saturation (DS) at the peak hour of the road segment Pangkajene-Empagae is 0.77 (service level C). This is indicating a steady current and the speed is controlled by traffics. The degree of saturation (DS) at peak hours of Sarawatu-Bilariawa local road is 0.21 included in category A service level, indicating free flow, low volume, and the driver can select the desired speed.

Table 3. The Matrix of SWOT Analysis

Internal Factors	Strengths	Weakness
	<ul style="list-style-type: none"> - The density of settlements along the roads is still relatively low - Access to the natural tourism area Puncak Bila - The investment potential of PT. BULI - Flat terrain type - The surface of the concrete road with good condition 	<ul style="list-style-type: none"> - No road drainage - There is no limitation of vehicle loading - The pattern of settlement land use elongated following the development of the road
External factors	Strategy (SO)	Strategy (WO)
<p>Opportunity</p> <ul style="list-style-type: none"> - As the main route connecting Pitu Riase Subdistrict with other areas - The road improvement plan refers to Spatial Planning of Sidrap Regency - Tourism area development plan <p>Threat</p> <ul style="list-style-type: none"> - Limited budget of local government - Population and vehicles are increasing every year 	<ul style="list-style-type: none"> - Develop roads to support tourist areas and farms <p style="text-align: center;">Strategy (ST)</p> <ul style="list-style-type: none"> - Increase the budget allocation for road maintenance and repairs 	<ul style="list-style-type: none"> - Add road drainage system - The addition of car cargo limit <p style="text-align: center;">Strategy (WT)</p> <ul style="list-style-type: none"> - Road improvement

Long-term vehicle growth rates (10 years) assuming a 3.5% growth rate corresponding to Decree of Directorate Generale of Highways indicate that on the primary arterial road of Pangkajene-Empagae

in 2019 the value of the degree of saturation is 1.17, while on the local road Sarawatu-Bilariawa value degree of saturation 1.13. Both road segments are included in category F in that year, the traffic flow condition is hampered, the

speed is low and the traffic volume is above capacity, so it needs to be done capacity handling and traffic management. Some traffic management measures can be applied to urban arterial roads, while others cannot be applied easily [20].

Based on the analysis in the strategy of development policy and development of local road transportation, the result of the strategy of development of roads to support tourist area and livestock.

4. CONCLUSION

The saturation level of the Pangkajene-Empagae arterial road in the rush hour has a value of 0.77 with service level C where the current is stable, and the speed is controlled by the traffic. While the saturation level of the local Sarawatu-Bilariawa segment at rush hour has a value of 0.21 with service level A shows free flow, low volume, and the driver can select the desired speed. Based on predicted traffic growth, assuming 3.5% growth indicates that in 2019 on the Pangkajene-Empagae primary arterial road with a degree of saturation of 1.17 and in 2025 on Sarawatu-Bilariawa local streets with a degree of saturation of 1.13 it needs to be done capacity handling and traffic management. The strategy of development policy and development of local road transportation based on Analysis can be done road development to support tourist area and the farm. Completed signs and road markings need to be taken into account to restrict truckloads beyond the carrying capacity of roads.

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