Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 46 No. 1 (2025)

The Service Level of the National Road Section from Mamuju to Tampa Padang Airport, West Sulawesi

Arif Fuddin Usman [1], M Yamin Jinca [2], Abdul Rahman Rasyid [3]

[1] *Department of Marine Transportation, Graduate School, Makassar, 90134, Indonesia*

[2] *Department of Transportation, Graduate School, Hasanuddin University, 90245, Indonesia*

[3] *Department of Regional and City Planning, Faculty of Engineering, Hasanuddin University, 90245, Indonesia*

Abstract:- The road section connecting Mamuju City with Tampa Padang Airport is a vital transportation route in West Sulawesi Province. This section becomes a logistics route for goods and passengers when the national road from Majene is blocked by landslides, as well as connecting Mamuju City with Tampa Padang Airport and Belangbelang Harbor. In line with economic growth, this road section is suspected of experiencing excess capacity. Moreover, West Sulawesi is a buffer zone for the National Capital (IKN) of the Archipelago in East Kalimantan. This research aims to analyze traffic density so that it influences the level of road service. This type of research is descriptive with a qualitative approach using the 1997 Indonesian Road Capacity Manual Method (MKJI). The results of the research state that the capacity and service level index (ITP) at the three monitoring points vary. Point 1 and point 2 with road type 2/2 UD have a capacity of 2,970 pcu/hour, while point 3 with type 4/2 D has a capacity of 3,069 pcu/hour. Volume Capacity Ratio (VCR) at sampling point 1 with an average VCR value of 0.30 (VCR < 1) at level of service 'B'. This means that traffic flow conditions are stable, operating speed is starting to be limited by other vehicles and obstacles are starting to be felt by surrounding vehicles. The average VCR value at sampling point 2 is 0.18 at level of service 'A' (VCR < 1), meaning that in free flow conditions at high speed, the driver can choose the desired speed without obstacles. The average VCR value at sampling point 3 with a two-way divided road type (4/2 D) has a value of 0.07 at level 'A' (VCR < 1), meaning that in free flow conditions at high speed, the driver can choose the appropriate speed. desired without any obstacles

Keywords: Traffic Volume, Road Service Level, MKJI 1997.

1. Introduction

West Sulawesi Province (Sulbar) is the 33rd province out of 38 provinces in the Unitary State of the Republic of Indonesia (NKRI) which was formed in accordance with Law Number 26 of 2004 [1]. The Province of West Sulawesi was ratified in a Plenary Meeting between the Government and the DPR RI, then inaugurated by the Minister of Home Affairs on behalf of the President of the Republic of Indonesia on October 16 2004 with the provincial capital being Mamuju [2].

As a developing region, Mamuju in West Sulawesi relies heavily on road access as infrastructure for land transportation to support development [3], especially national roads as an aspect of supporting accessibility in the province [4]. Roads as part of the national transportation system have an important role in supporting the economic, educational, social and cultural and environmental sectors. Roads are a vital need to connect land, sea and air modes of transportation [5].

A good transportation system is a form of connection or bond between passengers, goods, infrastructure and facilities that are interconnected in the context of moving people or goods, which are connected in an area or

concept, whether naturally or artificially or engineered [6]. The system expected from road transportation through a regional development approach is to achieve balance and equitable development between regions, form and strengthen national unity to strengthen national defense and security, and form a spatial structure in order to realize national development targets [7,8].

West Sulawesi has six districts namely; Polewali Mandar (Polman), Mamasa, Majene, Mamuju, Central Mamuju, and Pasangkayu. West Sulawesi relies heavily on the Trans Sulawesi road as access for equitable economic development in the six districts. West Sulawesi has a national road length of 546.49 km, a provincial road length of 671.00 km, and a district road length of 6,136.38 km [9].

West Sulawesi, with its capital city Mamuju, is supported by air transportation, namely Tampa Padang Airport and sea transportation at Belangbelang Harbor. Both are north of Mamuju City. Tampa Padang Airport is 26 km away, annually serving 657 departures and 657 arrivals [10]. Belangbelang Port, which is 45 km from Mamuju City, was visited by 452 ships and was involved in the T8 Route Network Sea Toll Program. Airports and ports, according to Jinca, M.Y [11]. is a development of future transportation demands. This national road also connects Mamuju City with Central Mamuju, Mamasa, and Pasangkayu Regencies as well as Central Sulawesi Province.

This research was conducted to determine: 1) Daily traffic volume (LHR) and existing road capacity on the national road section of the Mamuju City Boundary-Tampa Padang Airport Section? 2) Volume Capacity Ratio (VCR) and service level index (ITP) on the national road for the Mamuju City Boundary-Tampa Padang Airport Section.

2. Materials and Metods

2.1. Research Design

This research is descriptive field research with a qualitative approach. The data used comes from information about what is important and what is needed [12]. Therefore, by using qualitative research methods researchers can discover and understand hidden things in phenomena that are difficult to understand satisfactorily [13].

The challenges faced by West Sulawesi are because some of its areas are on the map prone to earthquake disasters [12]. As a result of the earthquake that occurred in West Sulawesi, several times national road access was blocked by landslide material and land transportation was disrupted [13]. A serious earthquake occurred on January 15 2021 with a magnitude of 6.2. This natural disaster meant that access to the Trans Sulawesi Road from Majene was blocked by landslide material, leaving Mamuju City isolated. This means that access to logistical assistance and human transportation relies on the national road from the Mamuju City Btas Section to Tampa Padang Airport. Another condition, in line with economic growth, is that this road section is thought to exceed capacity limits and is prone to traffic jams [14].

This research was motivated by the condition of the Mamuju City Boundary Road - Tampa Padang Airport which experienced delays or congestion. Especially at the five intersection points of the Mamuju City Limits. In fact, this road section is the lifeblood of transportation from Mamuju City to the airport and port. There is a gap between das sollen, the ideal conditions that are expected and das sein, the reality that is currently happening. It is suspected that the available road capacity is not commensurate with the volume of vehicles passing through the road, causing the level of road service to decline. The research design is depicted as in Figure 1.

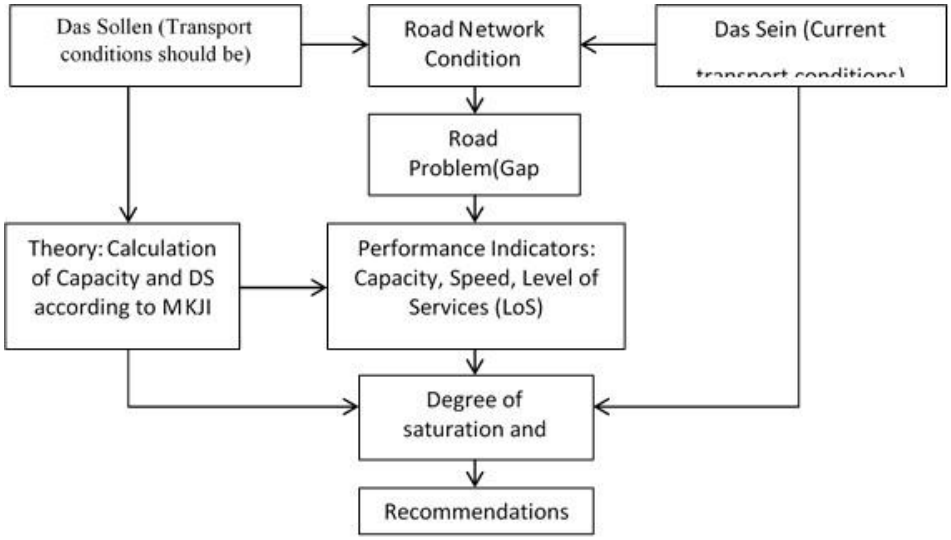

Figure 1. Research framework

2.2. Research Time and Location

The research location is Mamuju Regency, West Sulawesi. Vehicle sampling time was carried out at the beginning of the week for 12 hours on the grounds that it represented a normal working day, namely Monday (18/12/2023) from 06.00 – 18.00 WITA. Vehicle monitoring was divided into 3 sampling point locations which were carried out on the 2-Segment of the National Road from the Mamuju City Boundary - Tampa Padang Airport as in Figure 2. Point 1 was chosen because the starting point of the section was at Simpang 5, Mamuju City Boundary. This point was chosen because it represents an area of congestion, node meetings, and frequent delays or congestion. Point 2 was chosen because the junction of Jl Trans Sulawesi with the airport entrance road is a public transportation node. Point 3 was chosen because it is an intersection and is the meeting point from the north to the airport with Jl Lingkar Bandara. This sampling point was chosen to evaluate traffic density outside the city.

Figure 2. Research location sampling

2.3. Data Collection and Analysis Methods

Data collection techniques were carried out using observation, interviews and documentation. The main data from this research are the results of recording the number of vehicles, road geometry, vehicle speed, vehicle types and additional data such as previous survey documents [14]. Primary data was obtained directly through direct surveys in the field and researchers gathered information by direct interviews with respondents. This is done to obtain information on conditions, traffic volume, speed and road capacity. Secondary data is obtained by reading, studying, and understanding other information. This data was obtained from several journals and documents from related agencies, the National Road Implementation Center (BBPJN) XIII Makassar.

This research data analysis was carried out by simplifying the data into a form that is easier to read, understand and interpret. Data analysis in this research is descriptive qualitative using the 1997 MKJI method [15]. The analysis carried out is the capacity of the road, traffic behavior, speed, travel time, degree of saturation, and the level of service of the road can be seen in equations (1)-(3):

$$F_V = (F_{VO} + FVw)\ x\ FFVsf\ x\ FFVcs \quad (1)$$

where:

F_V is the free flow speed under field conditions (km/hour)

F_{VO} is the basic free flow speed (km/ hour)

FV_W is the speed adjustment for the effective width of the carriageway (km/ hour), the addition of

FFV_{Sf} is the adjustment factor for the condition of side obstacles, multiplication

FFV_{CS} is the adjustment factor for road function class, multiplication

$$C = C_0\ x\ FC_W\ x\ FC_{PA}\ x\ FC_{HS} \quad (2)$$

where:

C is capacity (pcu/hour)

C_0 is basic capacity (pcu/hour)

FC_W is the adjustment factor due to the width of traffic lanes

FC_{PA} is adjustment factor due to direction separation

FC_{HS} is adjustment factor due to side obstacles

$$Dj = Q/C \quad (3)$$

where:

D_j is the degree of saturation

Q is the total traffic flow Q (pcu/hour)

C is capacity (pcu/hour)

Speed and VCR

V/C < 1 = The road under review still meets the requirements.

V/C > 1 = The road under review has exceeded capacity, resulting in a decrease in quality.

3. Result and Discussion

3.1. Road Segment Caracteristics

The road section that is the focus of the research is national road section number '007 Kalukku-Batas Kota Mamuju with a length of 28.53 km. This section is included in Segment-2 of the West Sulawesi Trans Road with a length of 244.25 km from Jl. Ahmad Yani (Polewali City) section number '012.13 to the Kalukku-Batas Mamuju City section with section number '007. This road falls under the authority of the Makassar BBPJN XIII Hall.

The road sections in this study have a geometric width of 7 meters and type 2/2 UD (undivided) at sampling point 1 at Simpang 5, Mamuju City Limits and sampling point 2 at the junction of Jalan Bandara and Jalan Trans Sulawesi. to sampling point 3 has a width of 14 meters with type 4/2 D (divided). The road from point 1 to point 2 has an existing road shoulder of 1-2 meters without a road median. Separation of traffic flow per direction 50%-50%, mountain alignment type, with asphalt surface type.

The road characteristics from sampling point 1 to sampling point 2 are dominated by hills with ravine edges which cause the formation of vertical curves and horizontal curves (>2.5 rad/km). There are a number of sharp turns that cause passing vehicles to reduce speed [16]. The characteristics of roads with vertical curves and horizontal curves affect road geometry and reduce visibility for road users. This condition causes road capacity to decrease compared to the planned value [17]. Along the road, most of it is used by residents for gardening with medium side obstacles.

3.2. Traffic Volume and Composition

The traffic flow at observation or sampling point 1 of the Mamuju-Kaluku 2-Segment City Boundary Road Section reflects the volume and composition of traffic conditions that arise from the generation of daily vehicle movements. Traffic volume is expressed in vehicles or in passenger car units (pcu) per hour. The results of a traffic survey at 3 sampling points on the Mamuju–Kaluku City Boundary road in West Sulawesi Province are as follow.

a. Traffic Volume at Sampling Point 1 at Simpang 5 Batas Kota Mamuju

Table 1. The Most Dominant Type of Vehicle at Sampling Point 1, Simpang 5 Batas Kota Mamuju."

(2-Segment)

No	Location	Time	Motorcycle, Becak Motor (MC) - EMP (0.4)		Sedan, Taxi, Jeep, Petepete, Mikrolet (LV) – EMP (1.0)		Medium Truck, Truck 2 As, Heavy Truck, Trailer, Bus (HV) – EMP (1.3)		Total (PCU / hour)
1	Point 1 Intersection 5 Mamuju City	06.00-07.00	655	262	205	205	26	36,4	503,4
2		07.00-08.00	1709	683,6	415	415	30	42,9	1141,5
3		08.00-09.00	1320	528	369	369	27	41,6	938,6
4		09.00-10.00	1226	490,4	378	378	32	44,2	912,6

No	Location	Time	Motorcycle, Becak Motor (MC) - EMP (0.4)		Sedan, Taxi, Jeep, Petepete, Mikrolet (LV) – EMP (1.0)		Medium Truck, Truck 2 As, Heavy Truck, Trailer, Bus (HV) – EMP (1.3)		Total (PCU / hour)
5	Boundary (2-Segment)	10.00-11.00	1105	442	321	321	38	49,4	812,4
6		11.00-12.00	1383	553,2	314	314	30	39	906,2
7		12.00-13.00	1034	413,6	427	427	29	37,7	878,3
8		13.00-14.00	1340	536	358	358	41	53,3	947,3
9		14.00-15.00	1193	477,2	281	281	43	58,5	816,7
10		15.00-16.00	1460	584	341	341	50	71,5	996,5
11		16.00-17.00	1602	640,8	380	380	39	58,5	1079,3
12		17.00-18.00	1355	542	327	327	34	48,1	917,1
TOTAL			15382	6152,8	4116	4116	419	581,1	10849,9

Source: Data Analysis, January 2024

Based on Table 1, the most dominant types of vehicles are motorbikes and motorized rickshaws (bentor), from two directions of sampling points. Motorbike and bentor type vehicles reached 15,382 units per day or 6,152.8 pcu per day.

Motor cycle (MC) vehicles at this point often trigger traffic jams at Simpang 5, Mamuju City Limits, because they often take the route of drivers from the opposite direction, resulting in narrowing and delays. The characteristics of road users at the peak point are the majority of government employees, school students, company employees, and the general public who use motorbikes.

The highest daily traffic volume or peak from monitoring point 1 occurred at 07.00-08.00 WITA with MC types of 683.6 PCU/hour, LV of 415 PCU/hour, HV of 42.9 PCU/hour, and a total of 1,141.5 vehicles. Middle School/Hours. The activity of road users reaches its peak in the morning because they are on their way to work.

b. Traffic Volume at Sampling Point 2 in front of Majid Nurul Yakin

Table 2. The Most Dominant Type of Vehicle at Sampling Point 2 in front of Masjid Nurul Yakin (2-Segment)

No	Location	Waktu	Motorcycle, Becak Motor (MC) - EMP (0.4)		Sedan, Taxi, Jeep, Petepete, Mikrolet (LV) – EMP (1.0)		Medium Truk, Truck With 2 As, Heavy Truck, Trailer, Bus (HV) – EMP (1.3)		Total (PCU / Hour)
1	Point 2 in front of the	06.00-07.00	284	113,6	104	104	33	42,9	260,5
2		07.00-08.00	904	361,6	229	229	32	41,6	632,2

No	Location	Waktu	Motorcycle, Becak Motor (MC) - EMP (0.4)		Sedan, Taxi, Jeep, Petepete, Mikrolet (LV) – EMP (1.0)		Medium Truk, Truck With 2 As, Heavy Truck, Trailer, Bus (HV) – EMP (1.3)		Total (PCU / Hour)
3	Nurul Yakin Mosque, T-junction between Jl. Airport and Jl. Trans Sulawesi (2-Segment)	08.00-09.00	693	277,2	245	245	32	41,6	563,8
4		09.00-10.00	755	302	210	210	38	49,4	561,4
5		10.00-11.00	663	265,2	219	219	46	59,8	544
6		11.00-12.00	597	238,8	205	205	42	54,6	498,4
7		12.00-13.00	557	222,8	178	178	50	65	465,8
8		13.00-14.00	782	312,8	213	213	49	63,7	589,5
9		14.00-15.00	737	294,8	221	221	37	48,1	563,9
10		15.00-16.00	563	225,2	231	231	33	42,9	499,1
11		16.00-17.00	1046	418,4	294	294	45	58,5	770,9
12		17.00-18.00	901	360,4	167	167	41	53,3	580,7
TOTAL			8482	3392,8	2516	2516	478	621,4	6530,2

Source: Data Analysis, December 2023

Based on Table 2 above, the most dominant types of vehicles at sampling point 3 are motorbikes and motor rickshaws (bentor) or MC, from both directions of the road. The number of MC type vehicles is 8,482 units a day or 3,392.8 SMP / day. The characteristics of MC drivers at point 3 are government employees, school students, company employees and oil palm plantation farmers.

The highest daily traffic volume or peak volume from monitoring point 3 occurred at 16.00-17.00 WITA with MC types of 418.4 SMP/hour, LV of 294 SMP/hour and HV of 58.5 SMP/hour, and a total of 770 vehicles. 9 SMP/Hr. Road user activity reaches its peak in the afternoon, because they are returning from work locations, offices or oil palm plantations.

c. Traffic Volume at Sampling Point 3 in front of Indomaret Intersection, Jl Lingkar Bandara (2-Segment).

Table 3. The Most Dominant Type of Vehicle at Sampling Point 3 in front of Indomaret (2-Segment)

No	Location	Waktu	Motorcycle, Becak Motor (MC) - EMP (0.4)		Sedan, Taxi, Jeep, Petepete, Mikrolet (LV) – EMP (1.0)		Medium Truk, Truck With 2 As, Heavy Truck, Trailer, Bus (HV) – EMP (1.3)		Total (PCU / Hour)
1	Point 3	06.00-07.00	161	64,4	68	68	25	32,5	164,9

No	Location	Waktu	Motorcycle, Becak Motor (MC) - EMP (0.4)		Sedan, Taxi, Jeep, Petepete, Mikrolet (LV) – EMP (1.0)		Medium Truk, Truck With 2 As, Heavy Truck, Trailer, Bus (HV) – EMP (1.3)		Total (PCU / Hour)
2	Front of Indomaret Intersection of Jl Ring Bandara with Jl Trans Sulawesi (2-Segment)	07.00-08.00	270	108	100	100	32	41,6	249,6
3		08.00-09.00	217	86,8	72	72	29	37,7	196,5
4		09.00-10.00	203	81,2	136	136	37	48,1	265,3
5		10.00-11.00	222	88,8	136	136	14	18,2	243
6		11.00-12.00	180	72	109	109	16	20,8	201,8
7		12.00-13.00	180	72	126	126	28	36,4	234,4
8		13.00-14.00	165	66	121	121	33	42,9	229,9
9		14.00-15.00	159	63,6	93	93	21	27,3	183,9
10		15.00-16.00	191	76,4	113	113	26	33,8	223,2
11		16.00-17.00	262	104,8	132	132	31	40,3	277,1
12		17.00-18.00	193	77,2	160	160	19	24,7	261,9
TOTAL			2403	961,2	1366	1366	311	404,3	1775,1

Source:: Data Analysis, December 2023

Based on Table 3, the most dominant types of vehicles at sampling point 2 are motorbikes and motorized rickshaws (bentor), both from both directions of the road. MC type vehicles, namely motorbikes and bentors, totaled 2,403 units/day or 961.2 SMP/day. The characteristics of MC drivers are government employees, school students, company employees and oil palm plantation farmers.

The highest daily traffic volume or peak volume from monitoring point 2 occurred at 16.00-17.00 WITA with MC types of 101.8 SMP/hour, LV of 132 SMP/hour and HV of 40.3 SMP/hour, and a total of 277 vehicles. 1 SMP/Hour. Road user activity reaches its peak in the afternoon because they return home from work sites or oil palm plantations.

3.3 Analysis of Free Flow Speed

Free flow velocity (FV) is defined as the speed at zero flow level. FV is the speed that the driver will choose if driving a motorized vehicle without being influenced by other motorized vehicles on the road [21].

In accordance with the input data collected, the free flow speed calculation according to Equation (1) produces results according to the following table:

Table 4. Free Flow Speed by Vehicle Type

Jenis	FV0	FVw	FFVsf	FFVcs	FV
LV	68	0	0,85	0,97	56,07
MV	60	0	0,85	0,97	49,47
LB (Bus)	73	0	0,85	0,97	60,19
LT (Truk)	58	0	0,85	0,97	47,82
MC	55	0	0,85	0,97	45,35

Source: Data Anlysis, December 2023

Based on data from Table 4, the highest free flow speed (FV) at the research location came from the bus vehicle type with a Free Flow Speed value of 60.19 km/hour, followed by LV type vehicles with a value of 56.07 km/hour and the lowest was the MC type. with a value of 45.35 km/hour. Road conditions with asphalt pavement and relatively low side resistance values (VL-L) so that the driver can accelerate the speed of the vehicle.

3.4 Road Capacity

Road capacity is the maximum amount of traffic that can be accommodated on a road section during certain conditions (design, geometry, directional distribution and composition of traffic and environmental factors), which can be determined in passenger mass units (PCU/hour) [21]. Road capacity is influenced by several factors, namely basic capacity (Co), traffic lane width adjustment factor (FCw), direction separation adjustment factor (FCsp), side friction adjustment factor (FCsf), and city size adjustment factor (FCcs). For a clearer overview, the road capacity values at the research location can be seen in the following table.

Table 5. Road Capacity on Road Sections

Side Point on the Mamuju City Boundary Road - Tampa Padang Airport	Basic Capacity	Adjustment Factor for Road Capacity				Road Capacity
		Path Width	Direction Separator	Side Obstacles	City Size	
	Co	FCw	FCsp	FCsf	FCcs	
Sampling Point 1 (Direction to Mamuju)	3000	1	1	0,99	1	2.970,00
Sampling Point 1 (Direction to Palu)	3000	1	1	0,99	1	2.970,00
Sampling Point 2 (Direction to Mamuju)	3000	1	1	0,99	1	2.970,00
Sampling Point 2 (Direction to Palu)	3000	1	1	0,99	1	2.970,00

Side Point on the Mamuju City Boundary Road - Tampa Padang Airport	Basic Capacity	Adjustment Factor for Road Capacity				
		Path Width	Direction Separator	Side Obstacles	City Size	Road Capacity
	Co	FCw	FCsp	FCsf	FCcs	
Sampling Point 3 (Direction to Mamuju)	3100	1	1	0,99	1	3.069,00
Sampling Point 3 (Direction to Palu)	3100	1	1	0,99	1	3.069,00

Source: Data Analysis, December 2023

The analysis of road capacity calculations on the research location reaches 2,970 PCU/hour at Points 1 and 2. Meanwhile, at Point 3, with a four-lane road and a divided two-way (4/2 UD) road type, the capacity value is 3,069 PCU/hour.

3.5 Speed and Travel Time

Speed and travel time are primary performance metrics for road segments. To determine the speed and travel time on road sections at 3 monitoring points, refer to the following table

Table 6. Speed and Travel Time

Roads	Speed & Travel Time (MC)
Sampling Point 1 Location of Intersection 5 City Boundaries on Jl Boundary Mamuju City - Jl Poros Trans Sulawesi Mamuju-Palu (2-Way) - 2/2 TT	40 Km/Jam
Sampling Point 2 in front of the Nurul Yakin Mosque at the T-junction of Jl. Tampa Padang Airport - Jl. Poros Mamuju-Palu (2-Arah) – 2/2 TT	40 Km/Jam
Sampling Point 3 in Front of Indomaret on Jl Ringar Bandara - Jl Poros Mamuju-Palu (Mamuju Direction) 4/2 T	55 Km/Jam
Sampling Point 3 in Front of Indomaret on Jl Lingkar Bandara - Jl Poros Mamuju-Palu (Direction to Palu) 4/2 T	55 Km/Jam

Source: Data Analysis, December 2023

Based on Table 10 above, it shows that the speed and travel time for LV types, namely motorbikes and Bentors, is at a value of 40 – 55 Km/hour with an average of 47.5 Km/hour.

3.6 Degree of Saturation

The Degree of Saturation (DS) is the ratio between the volume of traffic flow to capacity, namely V/C. The DS value is shown in Table 6 to see whether the road segment has capacity problems or not. The degree of saturation is the ratio between vehicle volume and maximum road capacity. Vehicle volume is the space for the vehicle to move, while the volume is maximum. This analysis is useful for determining the level of service at each monitoring point on the road section being observed. In order to obtain a V/C value < 1, there needs to be changes

in traffic management on each road section.

Table 7. Degree of Saturation (DS) Per Hour at Monitoring Point

Time	Sampling Point 1					Sampling Point 2					Sampling Point 3				
	MC (0,4)	LV (1,0)	HV (1,3)	DS Total	Q/C	MC (0,4)	LV (1,0)	HV (1,3)	DS Total	Q/C	MC (0,4)	LV (1,0)	HV (1,3)	DS Total	Q/C
06.00-07.00	262	205	36,4	503,4	0,17	113,6	104	42,9	260,5	0,09	64,4	68	32,5	164,9	0,05
07.00-08.00	683,6	415	42,9	1141,5	0,38	361,6	229	41,6	632,2	0,21	108	100	41,6	249,6	0,08
08.00-09.00	528	369	41,6	938,6	0,32	277,2	245	41,6	563,8	0,19	86,8	72	37,7	196,5	0,06
09.00-10.00	490,4	378	44,2	912,6	0,31	302	210	49,4	561,4	0,19	81,2	136	48,1	265,3	0,09
10.00-11.00	442	321	49,4	812,4	0,27	265,2	219	59,8	544	0,18	88,8	136	18,2	243	0,08
11.00-12.00	553,2	314	39	906,2	0,31	238,8	205	54,6	498,4	0,17	72	109	20,8	201,8	0,07
12.00-13.00	413,6	427	37,7	878,3	0,30	222,8	178	65	465,8	0,16	72	126	36,4	234,4	0,08
13.00-14.00	536	358	53,3	947,3	0,32	312,8	213	63,7	589,5	0,20	66	121	42,9	229,9	0,07
14.00-15.00	477,2	281	58,5	816,7	0,27	294,8	221	48,1	563,9	0,19	63,6	93	27,3	183,9	0,06
15.00-16.00	584	341	71,5	996,5	0,34	225,2	231	42,9	499,1	0,17	76,4	113	33,8	223,2	0,07
16.00-17.00	640,8	380	58,5	1079,3	0,36	418,4	294	58,5	770,9	0,26	104,8	132	40,3	277,1	0,09
17.00-18.00	542	327	48,1	917,1	0,31	360,4	167	53,3	580,7	0,20	77,2	160	24,7	261,9	0,09

Time	Sampling Point 1					Sampling Point 2					Sampling Point 3				
	MC (0,4)	LV (1,0)	HV (1,3)	DS Total	Q/C	MC (0,4)	LV (1,0)	HV (1,3)	DS Total	Q/C	MC (0,4)	LV (1,0)	HV (1,3)	DS Total	Q/C
Total	6152,8	4116	581,1	10850	3,65	3392,8	2516	621,4	6530,2	2,20	961,2	1366	404,3	2731,5	0,89

Source: Data Analysis, December 2023

Based on Table 7, the highest DS value at monitoring point 1 was 0.38 at 07.00-08.00 WITA, dominated by MC type vehicles with a total number of vehicles 1141.5 pcu/hour. Next, the results of observations at monitoring point 2, the highest DS value was 0.26 at 16.00-17.00 WITA, dominated by MC type vehicles with a total number of vehicles 770.9 pcu/hour. Observation results at point 3 showed that the highest DS value was 0.09 at 16.00-17.00 WITA, dominated by MC type vehicles with a total of 277.1 pcu/hour.

3.7 Service Level and Speed Operation Relationship

The level of service of a road is the service capability of a road which describes the quality of a road within the operating conditions of the road capacity. The level of service on the road section at the three monitoring points can be determined using the degree of saturation (equation 3). The level of services on the Mamuju City Boundary Road - Tampa Padang Airport is as follow:

Table 8. Monitoring Point Service Level Index Value

NO	LOCATION	TIME	VCR	ITP	LOCATION	VCR	ITP	LOCATION	VCR	ITP
1	Sampling Point 1 Location of Intersection 5 City Boundaries on Jl Boundary Mamuju City - Jl Poros Mamuju-Palu (2-Way)	06.00-07.00	0,17	A	Sampling Point 2 in front of the Nurul Yakin Mosque at the T-junction of Jl. Tampa Padang Airport - Jl. Poros Mamuju-Palu (2-Way)	0,09	A	Sampling Point 3 in Front of Indomaret on Jl Ringar Bandara - Jl Poros Mamuju-Palu (2-Way)	0,05	A
2		07.00-08.00	0,38	B		0,21	B		0,08	A
3		08.00-09.00	0,32	B		0,19	A		0,06	A
4		09.00-10.00	0,31	B		0,19	A		0,09	A
5		10.00-11.00	0,27	B		0,18	A		0,08	A
6		11.00-12.00	0,31	B		0,17	A		0,07	A
7		12.00-13.00	0,30	B		0,16	A		0,08	A
8		13.00-14.00	0,32	B		0,20	A		0,07	A
9		14.00-15.00	0,27	B		0,19	A		0,06	A
10		15.00-16.00	0,34	B		0,17	A		0,07	A

NO	LOCATION	TIME	VCR	ITP	LOCATION	VCR	ITP	LOCATION	VCR	ITP
11		16.00-17.00	0,36	B		0,26	B		0,09	A
12		17.00-18.00	0,31	B		0,20	B		0,09	A
Rata-rata			0,30	B		0,18	A		0,07	A

Sourve: Data Analysis, December 2023

The results of the analysis of Service Level Index (ITP) values as in Table 8 for monitoring point 1 have an average value of B, meaning that traffic flow conditions are stable, operating speed is starting to be limited by other vehicles and obstacles are starting to be felt by surrounding vehicles. Sampling point 2 has an average ITP value of A of 0.18, meaning that in free flow conditions at high speed the driver can choose the desired speed without obstacles. Sampling point 3 has an average ITP value of A of 0.07, meaning that in free flow conditions at high speed the driver can choose the desired speed without obstacles.

The relationship between ITP or Level of Services (LOS) and Volume Capacity Ratio (VCR) at 3 monitoring points is depicted in Figure 6. Based on the analysis of the degree of saturation (Equation 3), the average VCR value at sampling point 1 is 0, 30 (VCR < 1) at a speed of 40 km/h. The average VCR value at sampling point 2 is 0.18 (VCR < 1) at a speed of 40 km/hour. The average VCR value at sampling point 3 with a two-way divided road (4/2 D) is 0.07 (VCR < 1) at a speed of 55 km/hour.

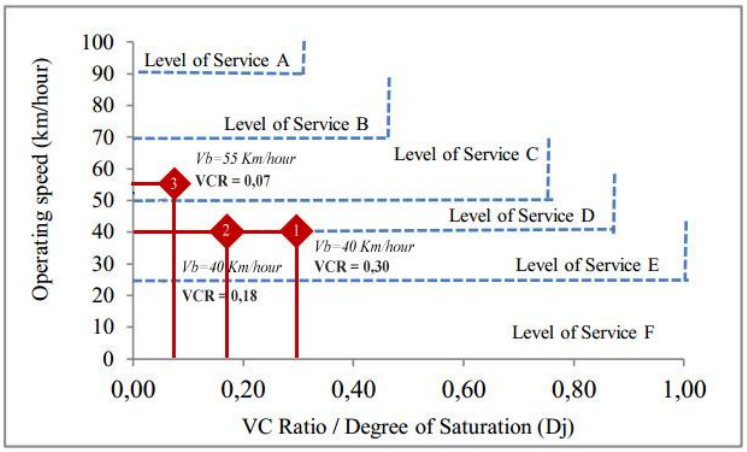

Figure 3. Relationship between road level of service and vehicle operating speed

4. Conclusion

The Mamuju-Kaluku City Boundary National Road section is an arterial road which is the lifeblood of the economy and regional development. The findings from researchers, capacity and service level indices at the three monitoring points varied. Point 1 and point 2 with road type 2/2 UD have a capacity of 2,970 pcu/hour, while point 3 with type 4/2 D has a capacity of 3,069 pcu/hour. Volume Capacity Ratio (VCR) at sampling point 1 with an average VCR value of 0.30 (VCR < 1) at level of service 'B'. This means that traffic flow conditions are stable, operating speed is starting to be limited by other vehicles and obstacles are starting to be felt by surrounding vehicles. The average VCR value at sampling point 2 is 0.18 at level of service 'A' (VCR < 1), meaning that in free flow conditions at high speed, the driver can choose the desired speed without obstacles. The average VCR value at sampling point 3 with a two-way divided road type (4/2 D) has a value of 0.07 at level 'A' (VCR < 1), meaning

that in free flow conditions at high speed, the driver can choose the appropriate speed. desired without any obstacles. In line with economic development in West Sulawesi Province, a policy is needed to regulate two-wheeled drivers who are oil palm plantation workers by building separate roads. This plantation activity has the potential to reduce the level of service on roads.

References

[1] Kominfo. Sejarah Sulawesi Barat (2017). https://berita.sulbarprov.go.id/index.php/blog/sulawesi-barat

[2] Yuliana, Mafilda Hadi. Strategi Pemerintahan Daerah Dalam Rencana Pembentukan Daerah Otonom Baru (DOB) di Kabupaten Mamuju Provinsi Sulawesi Barat. Diss. Institut Pemerintahan Dalam Negeri, 2022.

[3] Silondae, Sutami. Keterkaitan Jalur Transportasi Dan Interaksi Ekonomi Kabupaten Konawe Utara Dengan Kabupaten/Kota Sekitarnya. Diss. Haluoleo University, 2016.

[4] Fadly Ibrahim, Lawalenna Samang. "Pendekatan Analisis Multi Kriteria Dalam Pemilihan Trase Jalan Pada Kawasan Terisolir Aralle Tabulahan Mambi (ATM) Provinsi Sulawesi Barat." ISBN 978-979-16225-5-4. Prosiding Konferensi Nasional Pascasarjana Teknik Sipil (2010).

[5] Aprilia, Pratiwi, Lucia IR Lefrandt, and Sisca V. Pandey. "Analisis Pemilihan Moda Transportasi di Tondano." TEKNO 19.79 (2021).

[6] Tang, J., Heinimann, H., Han, K., Luo, H., & Zhong, B. Evaluating resilience in urban transportation systems for sustainability: A systems-based Bayesian network model. Transportation Research Part C: Emerging Technologies, 121, 102840 (2020).

[7] Fatimah, S. (2019). Pengantar transportasi. Myria Publisher. https://urlis.net/3vn8h905

[8] Tang, J., Heinimann, H., Han, K., Luo, H., & Zhong, B. Evaluating resilience in urban transportation systems for sustainability: A systems-based Bayesian network model. Transportation Research Part C: Emerging Technologies, 121, 102840 (2020).

[9] Central Bureau of Statistics. Sulbar in Figures (2018)

[10] Central Bureau of Statistics. Sulbar in Figures (2022)

[11] M. Y. Jinca. Transport Planning. Makassar: LPM of Hasanudin University (2002).

[12] Priadi, R. Arsyad, M. Susanto, A. "Evaluasi Kerentanan Seismik Wilayah Kota Mamuju Pasca Gempa Bumi 15 Agustus 2021 Menggunakan Data Microtremor." Jurnal Fisika Unand 13.1 (2024): 75-81.

[13] Ahmad, M. S. S. I., Sahara, S., & Wahyuni, A. Identifikasi Potensi Longsor Dengan Metode Geolistrik Di Desa Onang Utara Kecamatan Tubo Sendana Kabupaten Majene. Teknosains: Media Informasi Sains dan Teknologi, 16(2) (2022), 179-190.

[14] Morlok, Edward K., and Johan Kelanaputra Hainim. "Pengantar teknik dan perencanaan transportasi." Penyunting Yani Sianipar, Penerbit Erlangga, Jakarta (1988).

[15] Gunawan, I. Metode penelitian kualitatif. Jakarta: Bumi Aksara, 143 (2013).

[16] Yusuf, A. M. Metode penelitian kuantitatif, kualitatif & penelitian gabungan. Prenada Media (2016).

[17] Moleong, L. J. Metodologi penelitian kualitatif. Remaja Rosdakarya (2019).

[18] Kusnandar, Erwin. "Pengkinian Manual Kapasitas Jalan Indonesia 1997." Jurnal Jalan dan Jembatan 26.2 (2009): 1-11.

[19] Nasution, Surya Michrandi, et al. "Heterogeneous traffic condition dataset collection for creating road capacity value." Big data and cognitive computing 7.1 (2023): 40.

[20] Waloejo, Budi Sugiarto. "Road network–land use interaction model: Malang City in Indonesian case." IOP Conference Series: Earth and Environmental Science. Vol. 70. No. 1. IOP Publishing, 2017.

[21] Indonesia, Manual Kapasitas Jalan. "Departemen Pekerjaan Umum." Direktorat Jenderal Bina Marga (1997).