

THE ALTERNATIVE PLANNING ROUTES FOR PANCUR BATU-BANDAR BARU

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Abstract: The National Road that connects Medan-Berastagi is a very important route, because besides the tourist and trade routes that connects Berastagi. At peak conditions, especially at weekends, the 31 km long traffic jam has often occurred, starting from the direction of Pancur Batu to Bandar Baru and also the opposite direction. This study aims to evaluate the performance of the existing Trans Sumatra Road, Pancur Batu-Bandar Baru Route the wording to obtain the current level of road service, to provide an alternative route, the Pancur Batu-Bandar Baru route. The results of the traffic performance analysis of the existing conditions found that the evaluation traffic volume = 3,580 pcu / day, road capacity = 2,610 pcu / hour, VCR = 1.37, actual travel speed = 14.625 km / hour. the wording to obtain an alternative route, a tracking survey, geometric, spatial conditions and topography were carried out on two alternatives. Alternative 1 is 38 km long via Tuntungan Village and alternative 2 is 59 km long via Delitua District. In general, the topography of alternative path 2 is more steeply contoured than alternative 1 so that in this study the alternative 1 was chosen to be the alternative route for the Pancur Batu-Bandar Baru route. The results of alternative 1 planning show that VCR only meets the requirements until 2024 so that more in-depth research is needed.

Keywords: alternative, planning, performance, road, route, traffic

A. Introduction

a. Background

In fact, city changes and developments are determined by three factors, namely the population factor, the activities factor and the population movement's factor between activities. The increase in population and the development of activities will cause the need for space to increase. This occurs when there are physical changes and changes in city conditions and causes changes in population (Aldilase et al., 2014).

Activities that vary encourage the community to do movements in fulfilling their needs. Movements require infrastructure transportation such as roads and bridges which is the space where the traffic is and moving vehicles to move from a place of origin to a destination (Patunrangi, 2011).

The objective of road transport services is to form a traffic and road transport in safe, secure, fast, fluent, order and regular, comfort and efficient, integrated with others mode, reachable by all land region, and support fair distribution, development and stability to drive, to motor, and to support national development with reachable cost by community. According to that objective, it is needed a performance evaluation which considering accessibility distribution, safety, efficiency, effectivity, reachable cost, and integrity with others transport system. The evaluation has a goal to value the level of service of existing road network. The evaluation result will be used to estimate and build the strategy of road network rehabilitation and development. The evaluation has a role in developing sustainable transportation system, which has a meaning as a sustainable system for individual /community, economy, and environment. (Santosa & Joewono, 2005)

The National Road that connects Pancur Batu-Bandar Baruis an important route. This 31 km route is a tourist and trade route that connects Berastagi City in Tanah Karo Regency, as a tourist area and vegetable producer, with Deli Serdang Regency and Medan City. This route is also an evacuation route for the people of Tanah Karo Regency and parts of Deli Serdang Regency in the event of a volcanic disaster such as Mount Sinabung and Mount Sibayak.

At peak conditions, especially on weekends, there are often long traffic jams starting from the direction of Pancur Batu to Bandar Baru and also the opposite direction. Congestion occurred from Bandar Baru to Pancur Batu in both directions. Particularly in Pancur Batu, congestion occurs due to spilled market activity and also public transportation terminals which cause a reduction in road capacity. Congestion occurs along almost all sections, especially during the peak season, namely during weekends and holidays.

Based on the results of the research, the road that passes through the Pancur Batu Market has the highest degree of saturation value, namely 0.712 with a total vehicle volume of 1845 pcu / hour while the road segment capacity is 2591 pcu / hour (Prayuda, 2018).

Seeing this condition, it is necessary to think about planning an alternative road that can support smooth traffic along this route. Alternative road planning is an effort to increase various types of activities and support the smooth flow of traffic in these areas so as to reach one area to another more efficiently and effectively (Jatmiko & Hermawan, 2016).

On one occasion, the current Governor of North Sumatra, Mr. Edy Rahmayadi, strongly supports the construction of the Medan-Berastagi alternative route as long as it is for the benefit of the community (Tuntas Online, 2020).that VCRs only meet the requirements until 2024 so that more in-depth research is needed.

b. Formulation of the problem

1. What is the condition of the performance of the Trans Sumatra Road, Pancur Batu-Bandar Baru Route, Deli Serdang Regency?
2. What if an alternative route of Pancur Batu-Bandar Baru is planned so that traffic can flow more smoothly?

B. Theory Basis

a. Planned Hour Volume

Planned Hour Volume (VJR) is the estimated number of vehicles during the peak hour when the survey is carried out, expressed in pcu/hour. The relationship between VJR and VLHR (Average Daily Traffic Volume) is formulated in the following equation (Direktorat Jenderal Bina Marga, 1997b):

$$VJR = VLHR \times K / F \dots\dots\dots (1)$$

Where:

- VJR = planned hour volume,
- VLHR = average daily traffic volume,
- K = rush hour traffic volume factor,
- F = the factor of variation in the traffic rate per quarter of an hour in an hour.

Table 1 K and F Values for VLHR Variation

ESTIMATED DAILY TRAFFIC VOLUME (VLHR)	FACTOR	
	K (%)	F
> 50.000	4 – 6	0,9 – 1
30.000 – 50.000	6 – 8	0,8 – 1
10.000 – 30.000	6 – 8	0,8 – 1
5.000 – 10.000	8 – 10	0,6 – 0,8
1000 – 5000	10 – 12	0,6 – 0,8
< 1000	12 – 16	< 0,6

Source:(Direktorat Jenderal Bina Marga, 1997b)

VJR is the value of the volume of the vehicle per hour used in planning.

b. Side Barriers

Roadside activities often result in traffic problems, this is known as side drag. Roadside activities that affect road conditions include:

- Pedestrian activity;
- Stopping public transport activities or other vehicles;
- Slow moving vehicle activities such as rickshaws, bicycles and so on;
- Activities of entering and exiting vehicles from the land along roads.

According to MKJI 1997(Direktorat Jenderal Bina Marga, 1997a), every activity beside the road has an effect based on the weight as follows:

- Pedestrian activity weighs 0.5;
- Public transportation activities or other vehicles that stop weighing 1.0;
- Activities of vehicles entering / leaving the road side weighs 0.7;
- Activity of vehicles that run slowly weighs 0.4.

c. Capacity of Inter-City Roads

Road capacity is the maximum number of vehicles that can be accommodated and is fixed on a road section at certain conditions and times. The capacity of roads is expressed in vehicle / hour or pcu / hour.

In connection with the alternative Pancur Batu-Bandar Baru road which is an inter-city road, the road capacity review according to the MKJI 1997 (Direktorat Jenderal Bina Marga, 1997a)is calculated as follows:

$$C = CO \times FCW \times FCSP \times FCSF \dots\dots\dots (2)$$

Where:

- C: Capacity (pcu/hour)
- CO: Basic capacity (pcu/hour)
- FCW: Road width adjustment factor
- FCSP: Directional separation adjustment factor (only for undivided roads)
- FCSF: Side and curb / curb adjustment factor

The results of the geometric road survey are used to determine the basic capacity of the surveyed road. In the existing condition equal to the ideal condition, all adjustment factors are equal to 1.0 so that the capacity is the same as the basic capacity.

d. Volume / Capacity Ratio

The ratio of volume / capacity (V/C ratio) according to (*Decree of the Ministry of Public Works No. 14 Year of 2006 concerning Management and Engineering of Road Traffic, 2006*)is the ratio between traffic volume and road capacity.

If the V/C value is <0.75 then the road is still feasible, but if the V/C value is > 0.75 then it is necessary to handle the road to reduce the level of traffic density (Widari et al., 2015).

e. Travel Speed

MKJI 1997 also makes travel speed one of the main measures of road performance apart from the V / C ratio (Directorate General of Highways, 1997a). Travel speed is the average speed of the surveyed vehicle space along the road.

$$V = L / TT \dots\dots\dots (3)$$

Where:

- V: Average speed of vehicle space (km / h)
- L: Length of road under review (km)

TT: Average travel time of vehicles along roads (hours)

f. Traffic Density

Density (density) or concentration is the number of vehicles occupying a certain length of lane or road, averaged over time (Khisty & Lall, 2003). Direct calculations for density can be obtained through aerial photographs, but are generally calculated by the following equation when velocity and current are known (Khisty & Lall, 2003).

$$q = vx k \dots\dots\dots (4)$$

Where:

- q = current (vehicle / hour)
- v = travel speed (km / h)
- k = average density (vehicle / km)

g. Road Service Level

Service level is the ability of roads and / or intersections to accommodate traffic in certain circumstances (*Decree of the Ministry of Public Works No. 14 Year of 2006 concerning Management and Engineering of Road Traffic*, 2006). The road under review is a primary arterial road, for the level of service it can be seen in Table 2 below.

C. Research Methods

a. Research Stage

In order to meet the target time and desired goals, it is necessary to make a stage in the implementation of this research. The research stages can be seen in Figure 1 below.

b. Research sites

Determination of the research location was carried out by considering the existing but not yet developed routes between Pancur Batu-Bandar Baru. The research location image can be seen in Figure 1 below.

Table 2 Service Levels and Related Operational Characteristics on Primary Arterial Roads

Service Level	Related Operating Characteristic
A	<ul style="list-style-type: none"> ▪ Free flow ▪ Traffic velocity > 100km/h ▪ There must always be clear visibility to overtake ▪ Traffic volume up to 20% of capacity (400 pcu/h, 2 way) ▪ About 75% of the overtaking action can be done with little or no delay
B	<ul style="list-style-type: none"> ▪ The beginning of stable flow ▪ Traffic velocity ≥ 80 km/h ▪ Traffic volume up to 45% of capacity (900 pcu/h, 2 way)
C	<ul style="list-style-type: none"> ▪ Traffic flow is still stable ▪ Traffic velocity ≥ 65 km/h ▪ Traffic volume up to 70% of capacity (1400 pcu/h, 2 way)
D	<ul style="list-style-type: none"> ▪ Approaching instability flow ▪ Traffic velocity decreased up to 60 km/h ▪ Traffic volume up to 85% of capacity (1700 pcu/h, 2 way)
E	<ul style="list-style-type: none"> ▪ Reached capacity condition with volume 2000 pcu/h, 2 way ▪ Traffic velocity is about 50 km/h
F	<ul style="list-style-type: none"> ▪ Restrained flow condition ▪ Traffic velocity < 50 km/h ▪ Volume below 2000 pcu/h

(Source: (Ministry of Public Works, 2006)

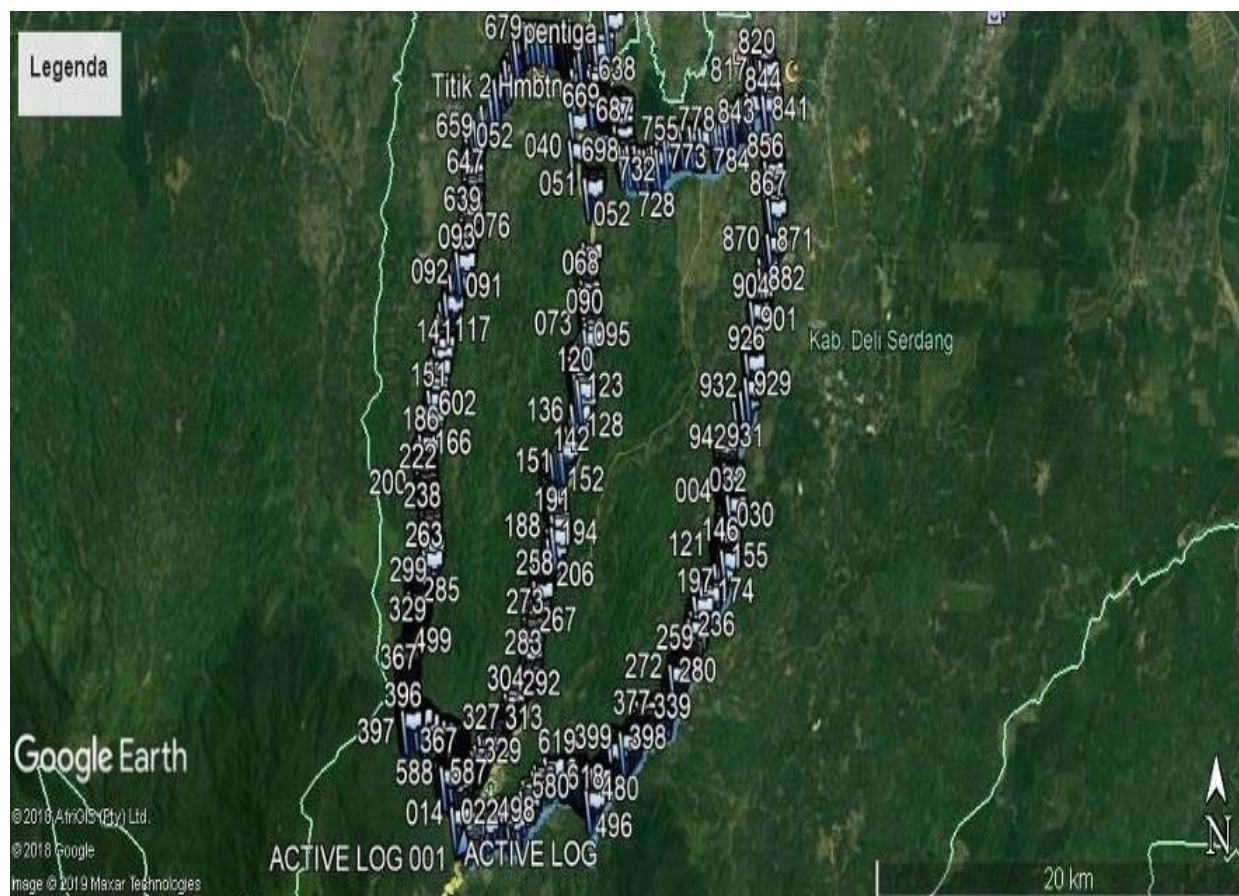


Figure 1 Study Location

Source: Google Earth, 2018 and Survey Results, 2019

D. Analysis and Discussion

a. Existing traffic conditions

The section under review is a section in the primary network system with arterial function and road class II, the authority to handle this road section is the authority given to the Central Government in this case the Ministry of Public Works and Public Housing.

Traffic flow on the section under review is obtained through a 24-hour traffic flow survey carried out for three consecutive days at the weekend and a 12-hour traffic survey conducted for 1 day which functions to validate the data previously surveyed. The 24-hour survey was conducted on 16-18 August 2019 while the 12-hour survey was conducted on 24 August 2019. From the three days of the survey, it was found that the maximum daily flow occurred on Saturday, namely 51,524 pcu / day. The maximum hourly flow was found on Saturday, August 17, 2019, 11.00-12.00, which is 3,580 pcu / hour. This data will later become the basis for evaluating traffic performance on the sections under review.

The calculation of road capacity according to the 1997 MKJI method is described as follows:

$$C = C_0 \times FCW \times FCSP \times FCSF$$

Where:

$$C_o = 3,000 \text{ pcu / hour}$$

$$FCW = 1.00$$

$$FCSP = 1.00$$

$$FCSF = 0.87$$

so that:

$$C = 3,000 \times 1 \times 1 \times 0.87 = 2,610 \text{ pcu / hour.}$$

VCR calculations can be seen as follows:

$$VCR = V / C$$

$$= 3,580 / 2,610$$

$$= 1.37$$

When the speed survey was conducted using a speed gun, the average travel speed of traffic was 26.625 km / hour.

Comparison of volume with speed found the following traffic density.

$$K = 3,580 / 26,625 = 134.45 \text{ pcu / km}$$

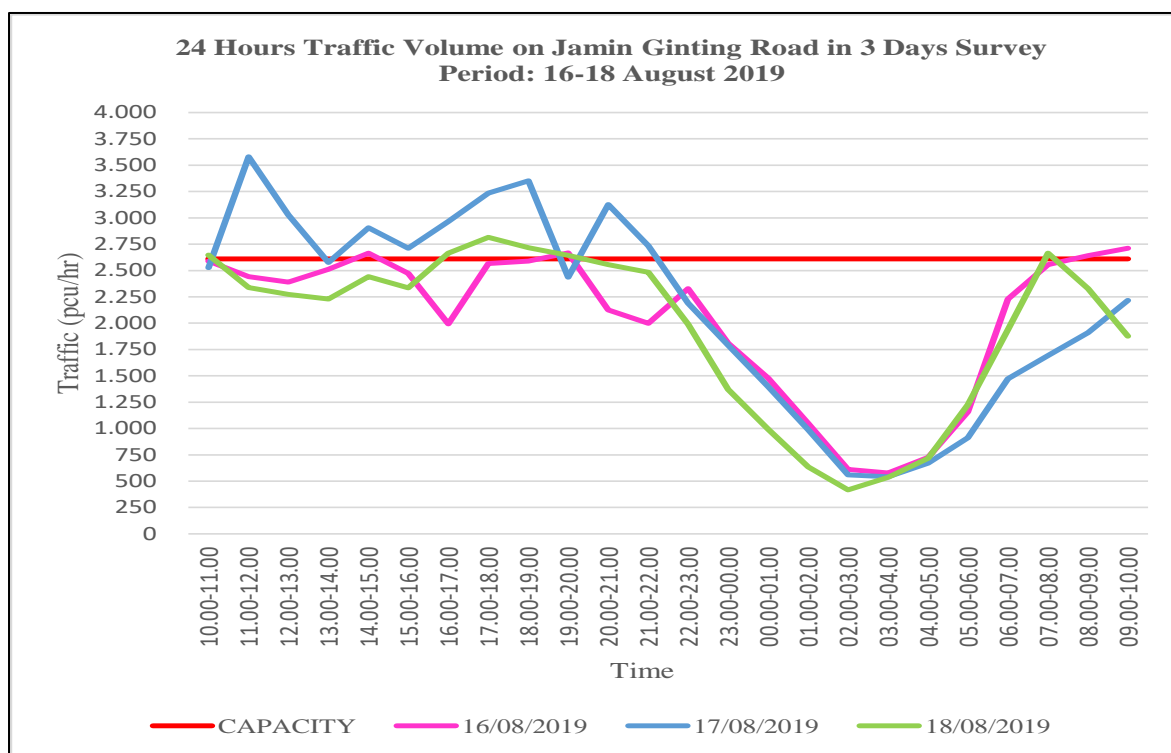


Figure 2 Maximum Day Traffic Conditions of Pancur Batu-Bandar Baru Section

Source: Survey results, 2019

b. Determination of Existing Road Service Levels

From the results of the traffic performance condition survey above, the service level of the Pancur Batu - Bandar Baru road section, namely the service level F means that the road is very jammed. In actual conditions according to Figure 3 above, it can be seen that this condition occurs for approximately 12 hours even though the congestion conditions fluctuate. Conditions gradually improved after 22.00 at night.

c. Alternative Path Planning

In this study, a physical search was conducted on the conditions of two alternative routes.

The first alternative is through Tuntung Village, Pancur Batu District to Suka Makmur Village, Kutalimbaru Subdistrict, leaving at Bumi Perkemahan Sibolangit, Sibolangit District, along approximately 38 km. On Map 1 this path is marked in orange.

From the Tuntung Simpang to Suka Makmur Village the road has been paved with concrete asphalt with a width varying between 4 m to 5.5 m and the shoulders are hardened with 1m wide concrete, but there are some places where the shoulders are still hardened with class C gravel piles or are still ground.

From Suka Makmur Village to Bumi Perkemahan Sibolangit, the road pavement has been heavily damaged and the width of the road is still 3 to 4 m narrow and the shoulders are not yet paved.

The contours and topography along the road are hilly with the slope of the road that is not too steep. This route partially enters the forest area in the Sibolangit Camping Ground so that if it is used as an alternative, there is a need for an environmental impact analysis study related to forest use.

The second alternative, which is through Deli Tua District, is continued to Sibiru-Biru District, exit at Bandar Baru. This route is approximately 59 km long. On Map 1. above Alternative Path 2 is blue. Starting from the Penambahan Junction on Jamin Ginting Street through Namo Bintang Village, Pancur Batu District to Pancur Batu Street - Delitua then head to Sibiru-Biru District. Along the road after the Sibiru-Biru Bridge, the road surface is already 5m wide in concrete asphalt.

In Sibiru-Biru and Sibolangit Districts, some roads are being upgraded with Rigid Pavement due to the Lau Simeme Dam Project so that the roads traversed by material trucks are not damaged.

In general, the topography of this path is hilly with a fairly steep road slope. So that alternative path 2 is not recommended to be an alternative route.

All alternative routes are still in Deli Serdang Regency, North Sumatra Province. In general, the topography of alternative 2 is more steeply contoured than alternative 1 and alternative 2 also has a farther distance than alternative 1 so that in this study the alternative route 1 is chosen to be the alternative route for the Pancur Batu-Bandar Baru route.

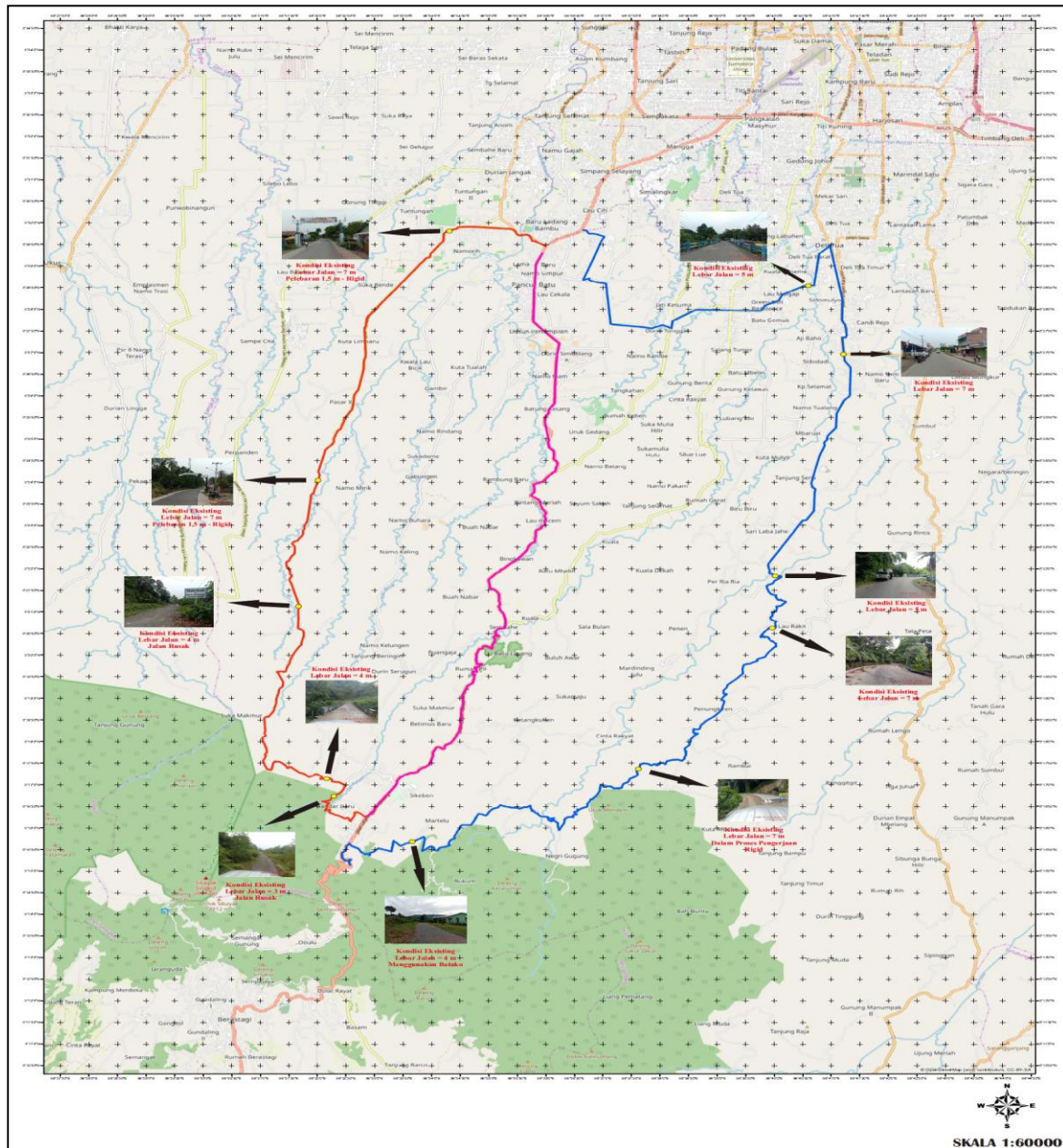
In Map 1 below, alternative routes 1 and alternative 2 can be seen, each of which has geometric characteristics characteristic of mountain roads.

d. Alternative Path Planning

In accordance with the conditions, the Alternative 1 route is the selected route for the Batu-Bandar Baru Pancur Line. Following is the path planning:

- Road Status: Provincial Road
- Road function: Primary Artery
- Street Class: Class 2
- The road consists of 2 lanes and 2 undivided directions with a width of 9 m, shoulders 1m and drainage of 1 m.

The planned traffic flow (VLHR) is based on the average daily traffic flow resulting from a 24-hour survey for the direction of Berastagi to Medan which occurred on Sunday, August 18 2019, which is 26,357 pcu / day. In the peak condition, the existing Medan-Berastagi route is made into one direction, only the direction from Medan that may pass from Berastagi is diverted to the planned alternative route 1.



Map 1 of the alternative route plan for Pancur Batu - Bandar Baru

Source: Open Street Map, 2019

Table 3 Potential Traffic Flow in 2019

No	Vehicle Category	Potential Traffic (pcu/h)	Factor	
			K (%)	F
1	Motor Cycle	11.445	7%	0,9
2	Light Vehicle	11.812	7%	0,9
3	Medium Heavy Vehicle	2.244	7%	0,9
4	Big Bus	501	7%	0,9
5	Heavy Vehicle	355	7%	0,9
Daily Volume		26.357	pcu/day	
Hourly volume		2.050	pcu/h	
Highest hourly volume		1.929	pcu/h	

For the review year for 20 years then the potential is determined, as can be seen in Table 4 below. The traffic growth rate is assumed to be 5% according to the conditions of economic and vehicle growth in North Sumatra. Calculated for 20 years with the assumption that operations start in 2024.

Table 4 Potential Traffic Flow for 20 Years

Vehicle Category	Potential Traffic (pcu/day/Direction) Assumption of 5% traffic growth rate					
	2019	2024	2029	2034	2039	2044
Motor Cycle	11.445	14.607	18.643	23.793	30.367	30.367
Light Vehicle	11.812	15.075	19.241	24.556	31.341	40.000
Medium Heavy Vehicle	2.244	2.864	3.655	4.665	5.954	7.599
Big Bus	501	639	816	1.041	1.329	1.696
Heavy Vehicle	355	453	578	738	942	1.202
Total	26.357	33.186	42.354	54.056	68.991	79.661

The volume of planning hours (VJP) is determined to be 2,050 pcu/hour even though on that day the highest current occurs 1,929 pcu / hour but what becomes VJP is calculated based on the formula $VJP = VLHR \times K / F$. In this case, the K factor is 7% and the F factor is 0.9. In Table 5 below, the potential flow of vehicles (VJP) for the next 20 years can be seen according to the length of the review year.

Table 5 Volume of Planning Hours for 20 Years

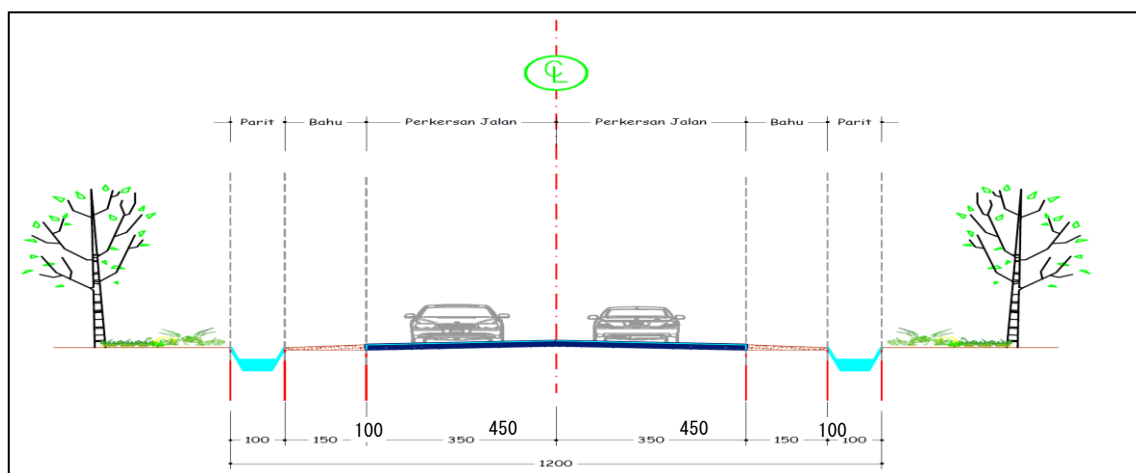
Vehicle Category	Planning Traffic Volume (pcu/h/Medan Direction) Assumption of 5% traffic growth rate					
	2019	2024	2029	2034	2039	2044
Motor Cycle	890	1.136	1.450	1.851	2.362	3.014
Light Vehicle	919	1.173	1.496	1.910	2.438	3.111
Medium Heavy Vehicle	175	223	284	363	463	591
Big Bus	39	50	63	81	103	132
Heavy Vehicle	28	35	45	57	73	94
Total Volume	2.050	2.616	3.339	4.262	5.439	6.942

The road width is planned to be 9 m with the consideration to anticipate the increasing volume of traffic going to Berastagi in the planned Review Year.

Table 6 VCR Year of Review for 9m Road Width

Item Calculation	Year review					
	2019	2024	2029	2034	2039	2044
Planning Traffic Volume(pcu/h)	2050	2616	3339	4262	5439	6942
Capacity (pcu/h)	3278	3278	3278	3278	3278	3278
VCR (DS)	1	1	1	1	2	2
Qualify	OK	OK	NO	NO	NO	NO

Based on the VCR calculation above, it turns out that the road is only able to meet the conditions until 2024. The service level for the road until 2024 is Service Level C. The traffic flow characteristics of service level C are stable flow, speed and mobility of vehicles is increasingly limited, the volume of service used for urban road design. As volume increases, motorcades of queues and road capacity decline.



E. Conclusions and Suggestions

a. Conclusion

From the results of the analysis and planning of the alternative route of Pancur Batu-Bandar Baru, the conclusions are summarized as follows:

1. The results of the traffic performance analysis show that the evaluation volume = 3,580 pcu / day, road capacity = 2,610 pcu/hour, VCR = 1,37, actual travel speed = 14.625 km/hour. Service level F, the characteristic of traffic flow that occurs is that it reaches a forced flow condition (choked up), the operating speed is very low, the volume has exceeded the road capacity, the formation of vehicle queues (many vehicles stop) and long traffic jams.
2. Survey results for tracking conditions, geometric, spatial conditions and topography for two alternatives:
 - a. Alternative 1, through Tuntung Village, Pancur Batu District to Suka Makmur Village, Kutalimbaru Subdistrict, exit at the Sibolangit Camping Ground, Sibolangit Subdistrict, approximately 38 km long.
 - b. Alternative 2, via Deli Tua through Kecamatan Sibiru-Biru exit at Bandar Baru. This route is approximately 59 km long.

In general, the topography of alternative 2 is more steeply contoured than alternative 1 and alternative 2 also has a farther distance than alternative 1 so that in this study the alternative route 1 is chosen to be the alternative route for the Pancur Batu-Bandar Baru route.

3. The results of the planning for the alternative route scenario, at the peak hour of the Medan Berastagi Line it only applies in one direction from the direction of Medan. For the direction from Berastagi using an alternative route that is planned, namely alternative route 1 through the Sibolangit Camping Ground to Simpang Tuntung. Provincial road status, primary arterial road function, Class 2, design pavement width 9 m, shoulder width 1 m, drainage width 1m. Plan road capacity = 3,278 pcu / hour, volume planning hour = 2,050 pcu / hour, VCR in 2024 = 0.80. Service level C, the traffic flow characteristics of service level C, namely stable flow, the speed and ability of the vehicle to move more limited, the volume of service used for urban road design. As volume increases, motorcades are queued and road capacity declines. Based on the calculation of the road traffic performance the plan only meets the requirements in 2024 for the other review years the conditions do not meet the requirements.

b. Suggestion

1. There needs to be a more comprehensive road planning related to this route, which is currently over saturated. Toll road alternatives may be a long-term solution but more in-depth research is needed.
2. There needs to be socialization to the community because many alternative routes pass through community-owned farming areas.

3. Alternative path 1 passes through the forest area so it is necessary to conduct an environmental impact analysis of the proposed alternative path 1 plan.

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