Planning for signal linking at 3 intersection in Sukabumi City

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Abstract. Transportation problems such as congestion, air pollution, accidents, queues, and delays can be encountered with low or large quantity levels. This problem is often encountered in several cities in Indonesia, including in Sukabumi. The growth in the volume of road traffic, especially in Sukabumi City, continues to increase rapidly due to the growth and development of cities and the rate of population growth. because the level of congestion, road capacity, and delays at these 3 intersections, the v/c ratio is still low, but it cannot be denied that if from year to year the volume and capacity of roads at these 3 intersections has increased continuously, it will cause congestion and road capacity exceeds its 0.78 v/c ratio. According to the calculation of the road capacity, it produces a total of 1,595 pcu/hour, according to the calculation of the maximum road capacity it produces 4,787 pcu/hour, so in anticipation of this reduction to 85% of the total percent of its maximum capacity, to 4,070, and from the calculation of Growth Factor it produces 3,978 in the year 2034, that means planning for implementing signal linking at its 3 intersections, namely in 2034.

1 Introduction

Transportation problems such as congestion, air pollution, accidents, queues and delays can be encountered in low or large quantities [1–9]. This problem is often encountered in several cities in Indonesia, including in Sukabumi. The growth in the volume of road traffic, especially in Sukabumi City, continues to increase rapidly as a result of the growth and development of the city as well as the rate of population growth [10]. Sukabumi City is a city that is at the center of economic, industrial, trade, educational and cultural activities in West Java [11,12], which is located 120 km south of Jakarta and 96 km from the provincial capital, Bandung [13,14]. Indirectly increasing the traffic flow of goods and services from surrounding areas [15].

The Mangkalaya, Gunungguruh, and Cemerlang intersections are 3 intersections in Sukabumi City that are not yet equipped with signal linking which is currently not implemented at these 3 intersections. However, the condition of traffic flow is still low, resulting in the implementation of the linking signal not yet being implemented, because the level of congestion, road capacity and delays at these 3 intersections has a low v/c ratio, but it cannot be denied that from year to year the volume and The road capacity at these 3

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intersections continues to increase, which will cause congestion and the road capacity will exceed 0.78 v/c ratio.

2 Material and Methods

The method used in this research is the Indonesian Road Capacity Manual Method.

2.1 Research sites

Research Site that we used in this reseach ir the Mangkalaya show in Figure 1, Gunungguruh show in Figure 2, and Cemerlang intersections show in Figure 3.

Fig. 1. Location of the Mangkalaya Intersection

Fig. 2. Location of the Gunungguruh Intersection

Fig. 3. Location of the Cemerlang Intersection

2.2 Study of literature

Literature studies aim to collect data or sources that can support and underlie the research to be conducted. Literature studies are obtained from various sources, namely journals, books, documentation, the internet and libraries [16–20].

2.3 Intersection Environmental Condition Data

Data on intersection environmental conditions were taken based on the results of a survey describing the type of road environment at each intersection arm, as well as side obstacles that occurred at 3 intersection locations.

2.4 Data collection

To obtain the objectives as previously explained, data collection was carried out. The data collection is classified into two, namely primary data and secondary data.

Primary data is data obtained from government agencies, including research reports, maps and photos. Primary data consists of Average Daily Traffic (LHR) data for the past several years, at 3 locations from the transportation department.

Secondary data was obtained from the results of literature, book and internet studies.

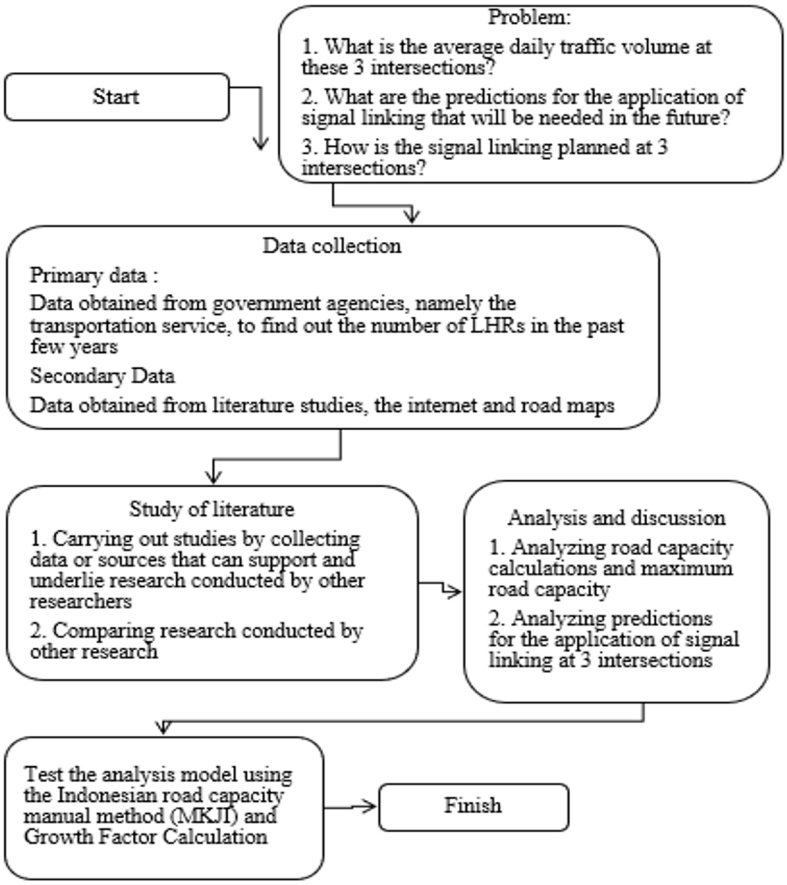

Fig. 4. Research Flow Chart

3 Results and Discussion

3.1 Geographical Location of Sukabumi City

The city of Sukabumi is located in the south central part of West Java at coordinates 106o 45' 50" East Longitude and 106° 45' 10" East Longitude, 6o 49' 29" South Latitude and 6º 50' 44" South Latitude, located at the foot of Mount Gede and Mount Pangrango with a height of 584 m above sea level, with a maximum temperature of 29ºC, a distance of 120 km from the National Capital (Jakarta) and 96 km from the Provincial Capital (Bandung) with an area of 4,800,231 Ha. At the end of 2002, the population was 269,142 people, with an average population density of 50 people/km2 spread out.

The entire Sukabumi City area borders the Sukabumi Regency area, namely: in the north it borders Cisaat District and Sukabumi District, Sukabumi Regency, in the South it borders Nyalindung District Sukabumi Regency, in the West it borders Cisaat District and Sukabumi District, Sukabumi Regency, in the East it borders Sukaraja District, Sukabumi Regency.

3.2 Geographical Location of Sukabumi Regency

Sukabumi Regency is located between 106º49 to 107º East Longitude 60º57 - 70º25 South Latitude with the following administrative boundaries: North with Kab. Bogor, to the south with the Indonesian ocean, to the west with Kab. Lebak, to the east of Kab. Cianjur. Sukabumi Regency is located between 106 degrees 49 to 107 degrees East Longitude and 60 degrees 57 to 70 degrees 25 South Latitude with administrative regional boundaries as follows: to the North with Bogor Regency, to the South with the Indonesian Ocean, to the West with Lebak Regency, to the East with Cianjur Regency.

3.3 Data Analysis for Road Capacity Calculations

The formula used to calculate urban road capacity based on the Indonesian Road Capacity Manual MKJI (1997), is as follows:

$$C = C_o \times FC_W \times FC_{SP} \times FC_{Sf} \times FC_{CS} \quad (1)$$

Information:

C : Capacity (pcu/hour)
C_o : Basic capacity for ideal conditions (pcu/hour) = 1650
FC_W : Traffic flow lane width adjustment factor = 3.00
FC_{SP} : Directional separation adjustment factor = 1.00
FC_{Sf} : Side resistance adjustment factor = 0.93
FC_{CS} : City size adjustment factor = 1.04

So we get a capacity value of:
C = 1650 x 3,00 x 1,00 x 0,93 x 1,04
= 4.787,6 smp/jam
= 4.787,6/3 = 1.595 smp/jam

3.4 Data Analysis for Calculation of Maximum Road Capacity

The formula used to calculate maximum urban road capacity based on the Indonesian Road Capacity Manual MKJI (1997), is as follows:

$$C = C_o \times FC_W \times FC_{SP} \times FC_{Sf} \times FC_{CS} \quad (2)$$

Information:

C : Capacity (pcu/hour)
C_o : Basic capacity for ideal conditions (pcu/hour) = 1650
FC_W : Traffic flow lane width adjustment factor = 3.00
FC_{SP} : Directional separation adjustment factor = 1.00
FC_{Sf} : Side resistance adjustment factor = 0.93
FC_{CS} : City size adjustment factor = 1.04

So we get a capacity value of:
C = 1650 x 3,00 x 3,93 x 0,93 x 1,04
= 4.787 smp/jam
Because the maximum capacity of the road is 4,787, in anticipation of reducing it to 85% of the maximum capacity, the number is 4,070.

3.5 Average Daily Traffic Data

Table 1. Average Daily Traffic Data

Years	Daily Traffic Data
2011	587
2012	634
2013	693
2014	725
2015	796
2016	842
2017	976
2018	1127
2019	1200

3.6 Growth Factor Calculation

Table 2. Growth Factor value in subsequent years

Years	Daily Traffic Data			
2011	587	634-587=47	(47÷587) x 100%	= 8.0 %
2012	634			
2012	634	693-634=59	(59÷634) x 100 %	= 9.3 %
2013	693			
2013	693	725-693=32	(32÷693) x 100 %	= 4.6 %
2014	725			
2014	725	796-725=71	(71÷725) x 100 %	= 9.7 %
2015	796			
2015	796	842-796=46	(46÷796) x 100 %	= 5.7 %
2016	842			
2016	842	976-842=134	(134÷842) x 100 %	= 15.9 %
2017	976			

Years	Daily Traffic Data			
2017	976	1127-976=151	(151÷976) x 100 %	= 15.4 %
2018	1127			
2018	1127	1200-1127=73	(73÷1127) x 100 %	= 6.4 %
2019	1200			
Average percentage				8.3%

Table 3. Growth Factor Calculation Table

Years	Growth Factor Calculation
2019	1200 x 0.083 = 100
2020	1200 + 100 = 1300
	1300 x 0.083 = 108
2021	1300 + 108 = 1408
	1408 x 0.083 = 117
2022	1408 + 117 = 1525
	1525 x 0.083 = 127
2023	1525 + 127 = 1652
	1652 x 0.083 = 138
2024	1652 + 138 = 1790
	1790 x 0.083 = 149
2025	1790 + 149 = 1939
	1939 x 0.083 = 161
2026	1939 + 161 = 2100
	2100 x 0.083 = 175
2027	2100 + 175 = 2275
	2275 x 0.083 = 189
2028	2275 + 189 = 2464
	2464 x 0.083 = 205
2029	2464 + 205 = 2669
	2669 x 0.083 = 222
2030	2669 + 222 = 2891
	2891 x 0.083 = 240
2031	2891 + 240 = 3131
	3131 x 0.083 = 260
2032	3131 + 260 = 3391
	3391 x 0.083 = 282
2033	3391 + 282 = 3673
	3673 x 0.083 = 305
2034	3673 + 305 = 3978
	3978 x 0.083 = 330

So for planning the implementation of signal linking at three intersections, namely in 2034.

3.7 Signal Linking Design and Analysis

Table 4. Design and Analysis of Signal Linking

Intersection	Green	Yellow	Red	Offset Relative (OR)	Distance
Cemerlang	45	7	35	0	0
Gunungguruh	35	7	25	45	2240
Mangkalaya	55	7	45	40	2280

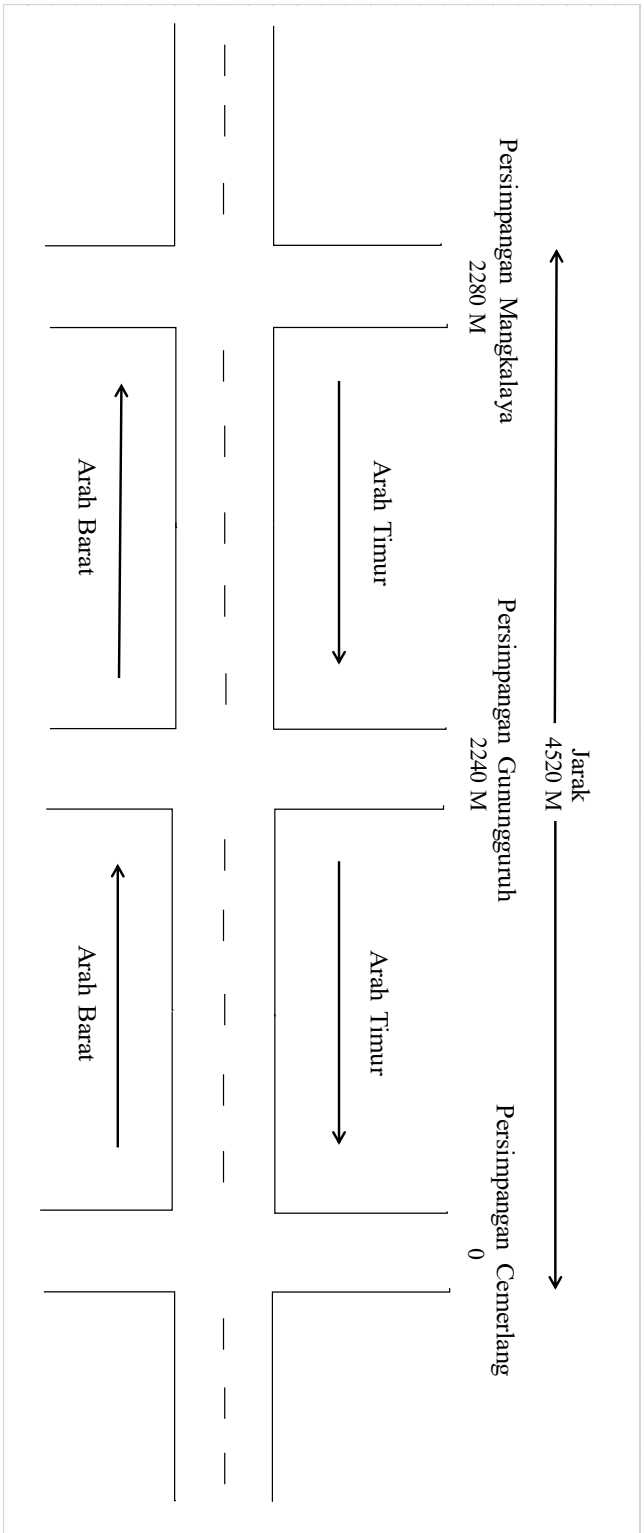

Fig. 5 Road Scheme

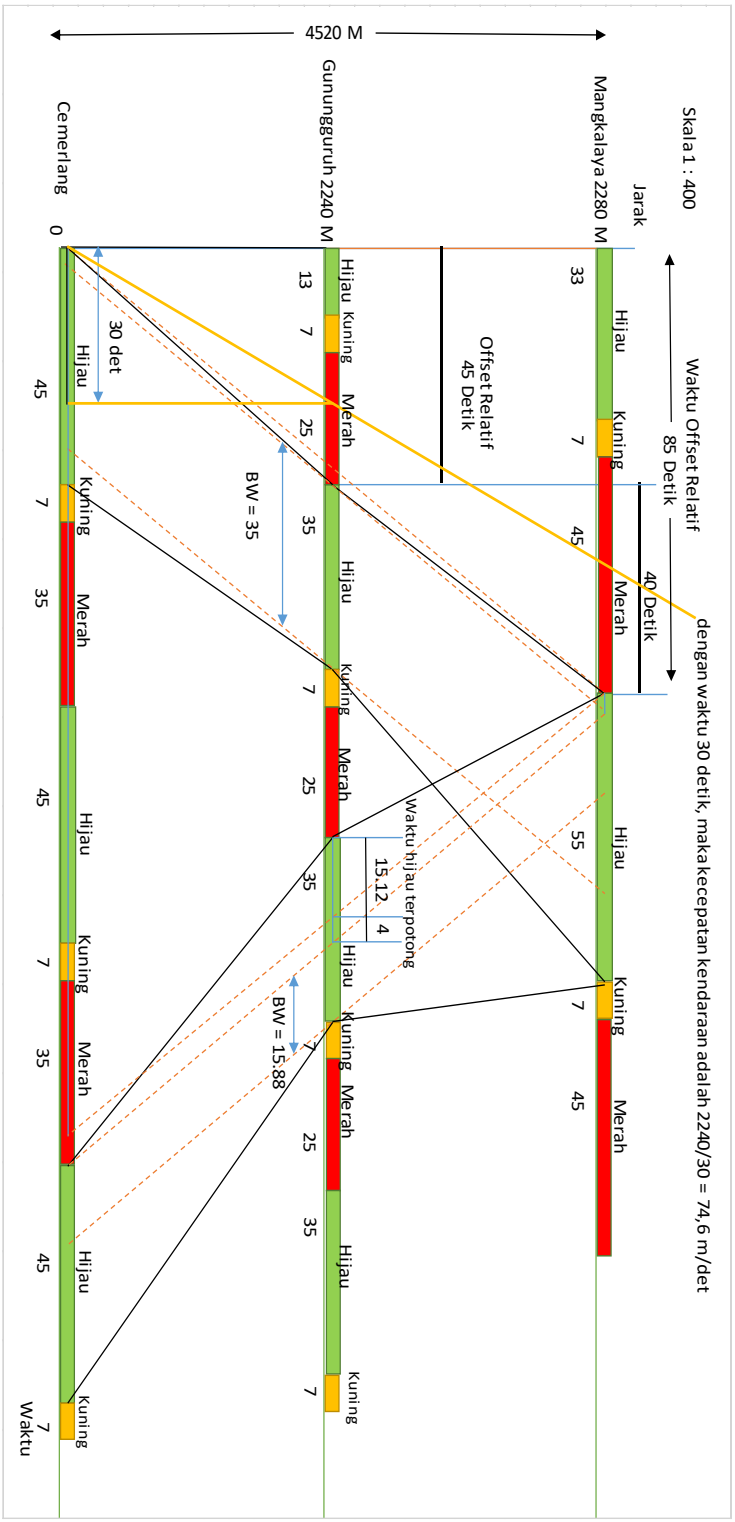

Fig. 6 Road Scheme

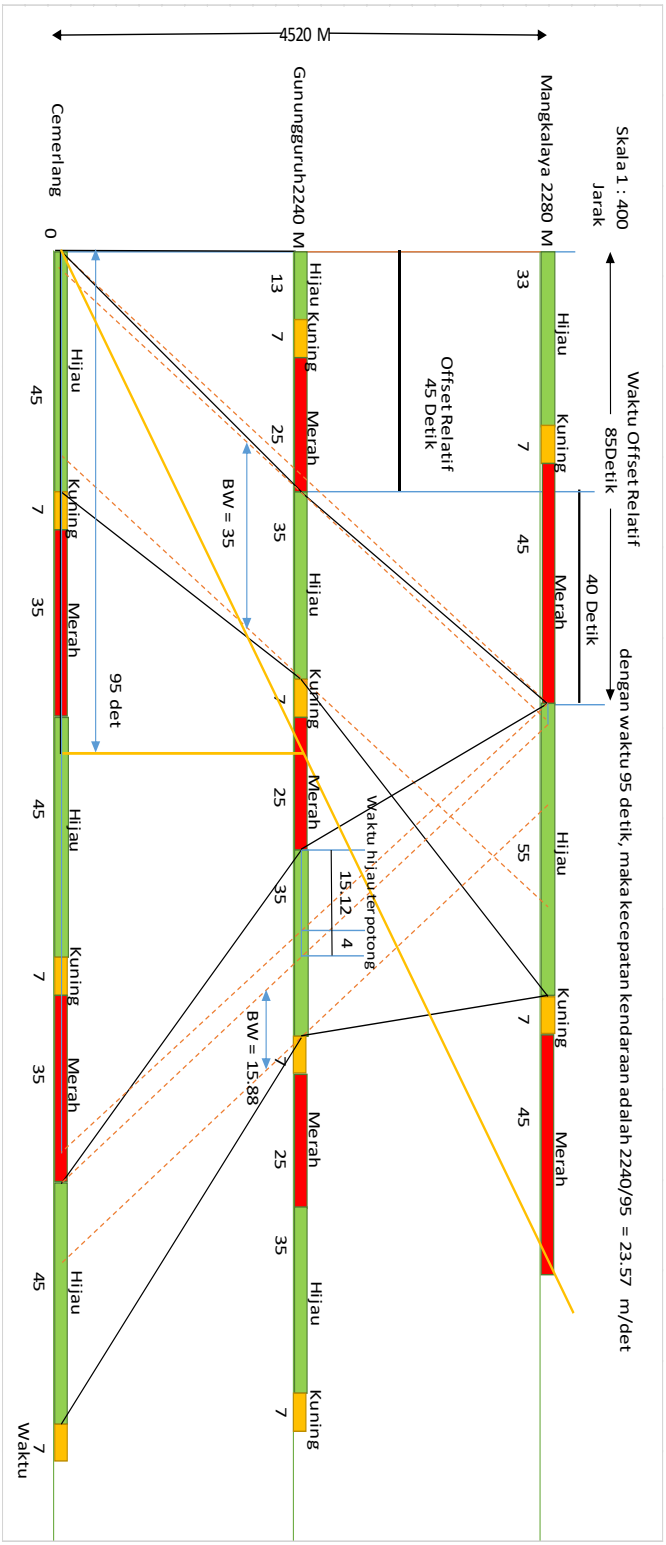

Fig. 7. Road Scheme

Bandwidth Efficiency:

$$\frac{\text{EFFBW}}{\text{C}} = \text{BW} \times 100$$
$$= \frac{35}{85} \times 100$$
$$= 41{,}17\%$$

Bandwidth Capacity

$$\text{CBW} = \frac{3600 \times BW \times L}{c \times h}$$
$$= \frac{3600 \times 35 \times 2}{85 \times 3}$$

= 988 vehicle/hour

To reach the Gunung Guruh intersection from the brilliant direction to the west:

$$Time = \frac{Distance}{Velocity} = \frac{2240}{53{,}17} = 42{,}13\ seconds$$

To reach the Mangkalaya intersection from Gunungguruh to the west:

$$Time = \frac{Distance}{Velocity} = \frac{2280}{53{,}17} = 42{,}88\ seconds$$

To reach the Gunung Guruh intersection from Cemerlang to the east:

$$Time = \frac{Distance}{Velocity} = \frac{2280}{53{,}17} = 42{,}88\ seconds$$

To reach the Cemerlang intersection from Gunung Guruh to the east:

$$Time = \frac{Distance}{Velocity} = \frac{2240}{53{,}17} = 42{,}13\ seconds$$

Calculating Bandwidth capacity:

$$\text{CBW} = \frac{3600 \times BW \times L}{c \times h} = \frac{3600 \times 15{,}88 \times 2}{85 \times 3} = 376\ vehicle/hour$$

4 Conclusion

The results of the calculation of road capacity according to the MKJI at the intersection of Mangkalaya, Gunungguruh and Cemerlang currently have an LHR of 1,595 pcu/hour. The results of the calculation of maximum road capacity according to the MKJI at the intersection of Mangkalaya, Gunungguruh and Cemerlang the LHR is 4,070 pcu/hour. The results of calculations using the Growth Factor produce an LHR in 2034 of 3,978. The results of the signal linking planning analysis can be used in 2034. The results of the Bandswitch capacity calculation from the west direction are 988 vehicles/hour. The results of the Bandswitch capacity calculations from the east direction are 376 vehicles/hour.

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