International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Priority Determination of Road Maintenance in Lumajang Regency Using the AHP Method

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Abstract

The inadequate conditions of road pavements can cause disruption to a community's economic, social and religious activities. The care of the road pavement's condition is done by many methods such as routine maintenance, and if necessary, road rehabilitation. The Lumajang District is divided into 368 roads with a length of 1.109 km spread across 21 sub-districts. With the number of roads in the Lumajang District, there are difficulties in monitoring the condition of each and every road in the Lumajang district. This includes selecting and prioritizing the maintenance of the roads. Prioritizing and handling the management of the roads is done in this research using the AHP method. The result of the priority designation study shows the first factor "road condition" to be the value of 0.328 (32.8%). The second factor of "policy" has a value of 0.250 (25%). The third factor of "connectivity" has a value of 0.166 (16.6%). The fourth factor of "traffic volume" has a value of 0.136 (13.6%). And the last factor of "land use" has a value of 0.119 (11.9%).

Keywords: AHP Method; Priority Determination; Road Maintenance.

1. Introduction

The road is a surface infrastructure for land transportation which includes its complimentary buildings and traffic equipment. This can be above/underground, or above/underwater.

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This does not include railways, *lori* tracks or cable lines. The road is an important infrastructure to connect one place to another or one economic center to another and the road pavement's condition would be important for the wellbeing for many of a society's economic, social and religious activities. Therefore, it is important to maintain the road's condition by routine maintenance (among others) and rehabilitation if necessary. A light routine maintenance is conducted for a road which has light or moderate damage, whereas a rehabilitation or/and road improvement is conducted for roads that are in the category of heavy damage. All of this is done to keep the it in a working condition for user activities and reach its road age plan. Lumajang Regency is divided into 368 roads with a length of 1,109 km spread over 21 sub-districts (by decree of Regent [1]) on the determination of roads by road function and status as a district road). The road conditions in Lumajang are differentiated into good, moderate damage, light damage and heavy damage conditions. With so many roads in Lumajang Regency, the Lumajang Regency has some difficulty in monitoring the condition of all the roads in Lumajang Regency as there are limited funds in road maintenance. This has resulted in the need of prioritizing the handling and maintenance of the roads to be more effective and accurate. There are similar researches that has been done of this topic. One of the such was conducted by [2], entitled "Priority handling of roads in North Bengkulu Regency". Another research conducted was by [3] with the title of the research, "Determining priorities for handling the District road in Bangli Regency". There is also one done by [4] under the research title of "Scale analysis of street priorities using Analytical method Hierarchy Process (AHP) in East Kalimantan Province". These are all done in different situations and locations for its particular case studies. In order to understand the handling and maintenance of these roads in Lumajang, it is necessary to conduct a study entitled "Priority Determination of Road Maintenance in Lumajang Regency Using the AHP Method ". This study is done for the government, the Lumajang Regency Government in particular, to understand the road segments which are prioritized to be built or maintained directly, quickly and precisely to create good facilities and infrastructures for the Lumajang community.

2. Research Methods

2.1. Preliminary Study

The activities carried out in this preliminary study are to identify the availability of supporting facilities in conducting this research. These include the selection of study locations, the availability of data, the availability of literature or reference literature and the availability of tools (in this case the software to conduct data analysis). This is done to consider the study's limited availability of time and funds. It is also to determine a certain benchmark in conducting the study. The results of this preliminary study are as the following:

a. Research location is in Lumajang district, specifically for the roads Argosari-B29, Wonokerto-Wonosari, Kalimas and Senduro-Ranupane;
b. Research time was conducted during working hours at the Lumajang District Public Works and Spatial Planning Office;
c. The object of the research was conducted at the Lumajang District Public Works and Spatial Planning Office;
d. Reference literature or literature as a basis for the theory is obtained from several textbooks related to the Analytical Hierarchy Process (AHP) method;

e. Software tools used in conducting the analysis is done by the Microsoft Excel Program.

2.2. Research Variable

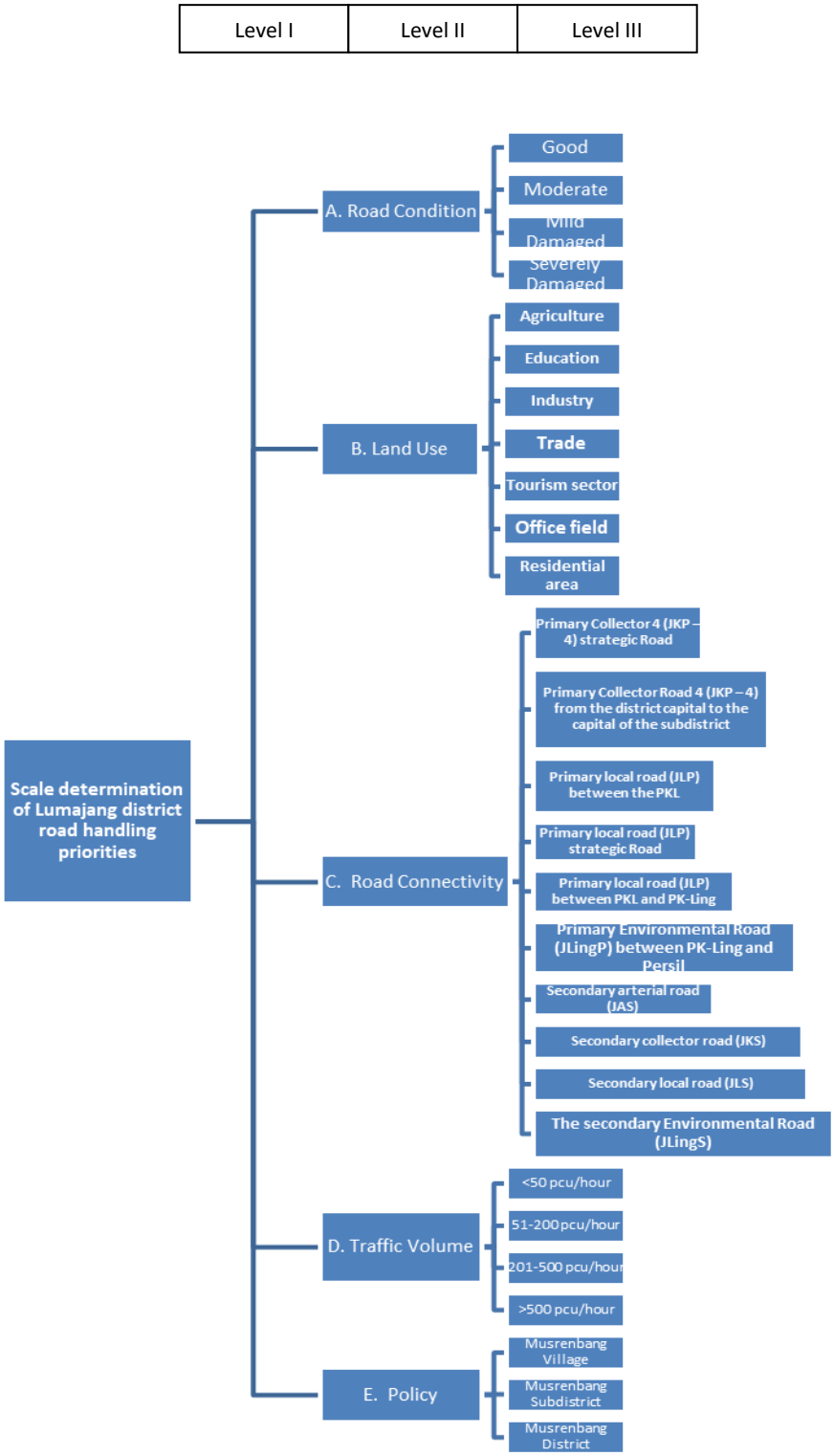

Figure 1: organization of hierarchy levels in the road maintenance

The variables used in this research consist of criteria/consideration which is the background of priority maintenance of district roads in Lumajang Regency. Variables in this new study will be formulated in the form of hierarchical structures after secondary data is obtained. In this research, the preparation of the level used in Analytical Hierarchy Process (AHP) method consists of 3 (three) levels as shown in figure 1.

1. Level 1 (Goal), is to determine the roads which has the highest priority in road maintenance.
2. Level II (Criteria), consist of criteria to determine the priority. These criteria are: road condition factor, land use factor, connectivity factor, traffic volume factor and policy factor.
3. Level III (development of Level II, hereinafter referred to as sub-criteria):

- Road condition factors (good, moderate damage, light damage, heavy damage);
- Land use (agriculture, education, industry, trade, tourism, residential and office);
- Road connectivity factor: concerning the roads such as Primary Collector 4 (Jalan Kolektor Primer, JKP – 4) a strategic road from the capital of the district to the capital of the subdistricts. Primary local roads (Jalan Lokal Primer- JLP) between (PKL) and (PK-ling). Primary Neighborhood Road (Jalan Lingkungan Primer - JLingP) between PK-Ling and Persil. Secondary artery road (Jalan Arteri Sekunder - JAS). Secondary Collector Road (Jalan Kolektor Sekunder - JKS), Local secondary road (Jalan Lokal Sekunder - JLS), Secondary Neighborhood Road (Jalan Lingkungan Sekunder - JLingS);
- Traffic volume factor (<50 pcu/hour, 51-200 pcu/hour, 201 – 500 pcu/hour, > 500 pcu/hour);
- Policy factors (Musrenbang village, Musrenbang subdistrict and Musrenbang district).

2.3. Data Analysis

This research uses qualitative methods in order to get a deeper analysis of the reality that occurs in the field. The Qualitative method is easier to make adjustments to when faced with a double reality. This method can also directly present the interpretation of researchers, and the respondents themselves. It can also give a more sensitive, and adaptive approach which may have various influences that occur against the pattern, aspects or values faced empirically [6]. To analyze and fulfill the objective of this study, the Analytical Hierarchy Process (AHP) is used to obtain the criteria and sub-criteria as described in section two above. The case study will be conducted in the road section Argosari-B29, Wonokerto-Wonosari, Kalimas and Senduro-Ranupane.

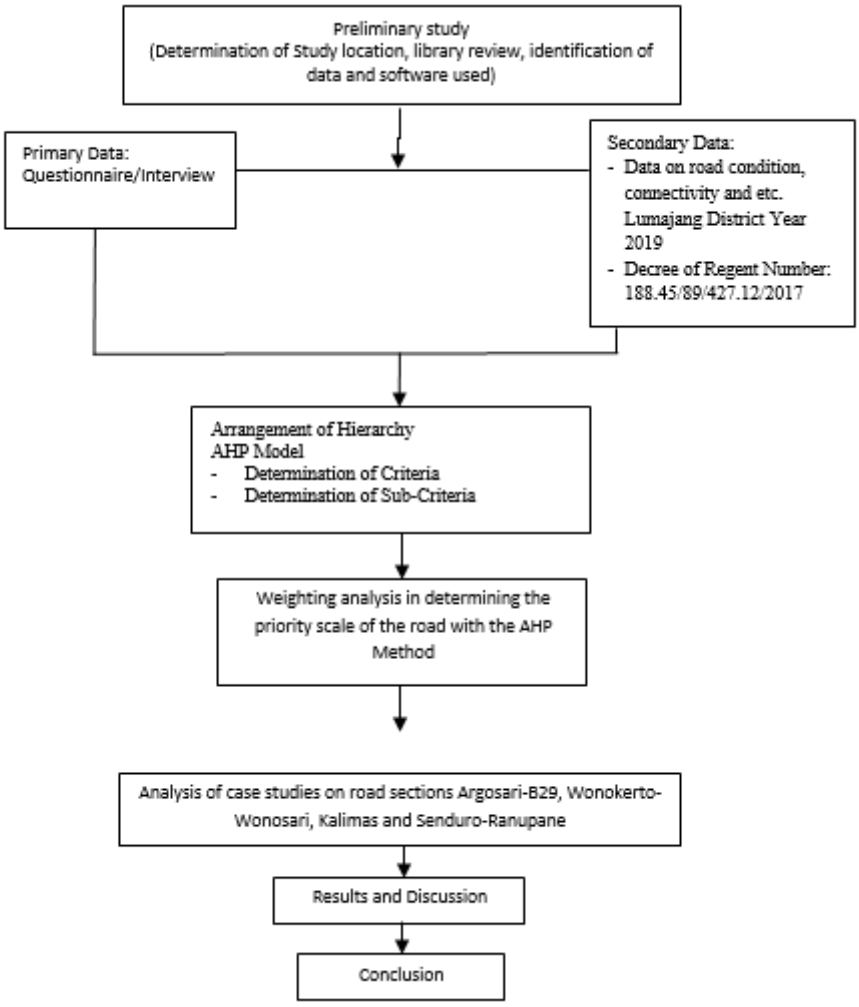

Figure 2: research flowchart

3. Results and Discussion

3.1. Weighting Analysis in Determining the Priority Scale of the Road with the AHP Method

For this discussion, the respondents selected for the research were 5 (five) respondents who possessed influence on the topic, namely the Head of Public Works and Spatial Planning of Lumajang Regency, the Head Section of Operations in the Area of Highways, the Head of Maintenance and Supporting Buildings of Highways, the Head of Road and Bridge Management Unit and Head of Technical and Construction Division.

3.1.1. Criteria Weighting (Level II)

Determining the criteria from the Analytical Hierarchy Process (AHP) is based on the factors of road condition, land use, connectivity, traffic volume and the policy from respondents. This is to be understood through distributed questionnaires. AHP method is then used as in Table 1.

Table 1: Weight Determination Criteria

Criteria	Weight
Road Conditions	0,328
Land Use	0,119
Road Connectivity	0,166
Traffic Volume	0,136
Policy	0,250
Amount	**1,000**

Table 1 shows that the weighting determination of criteria which can be prioritized first is the "Road Condition" factor with a value of 0.328 (32.8%), the second is the "Policy" factor with a value of 0.250 (25%), the third is the "Connectivity" factor with a value of 0.166 (16.6%), the fourth factor is the "Traffic Volume" with a value of 0.136 (13.6%), and the last is the "Land Use" factor with a value of 0.119 (11.9%).

3.1.2. Sub-Criteria Weighting (Level II)

The determination of the sub-criteria of the Analytical Hierarchy Process (AHP) method is to show the factors of the road maintenance from each criterion which was conducted by the respondents. The road maintenance factors that occurs on each criterion consists of:

- Road condition factors (good, moderate damage, light damage, heavy damage);
- Land use (agriculture, education, industry, trade, tourism, residential and office);
- Road connectivity factor: concerning the roads such as Primary Collector 4 (Jalan Kolektor Primer, JKP – 4) a strategic road from the capital of the district to the capital of the subdistricts. Primary local roads (Jalan Lokal Primer- JLP) between (PKL) and (PK-ling). Primary Neighborhood Road (Jalan Lingkungan Primer - JLingP) between PK-Ling and Persil. Secondary artery road (Jalan Arteri Sekunder - JAS). Secondary Collector Road (jalan kolektor sekunder - JKS), Local secondary road (Jalan Lokal Sekunder - JLS), Secondary Neighborhood Road (Jalan Lingkungan Sekunder - JLingS);
- Traffic volume factor (<50 pcu/hour, 51-200 pcu/hour, 201 – 500 pcu/hour, > 500 pcu/hour);
- Policy factors (Musrenbang village, Musrenbang subdistrict and Musrenbang district).

3.2. Road Condition Factor Analysis

Table 2: Road Conditions Factor

Factor	Weight
Good	0,060
Moderate Damage	0,139
Light Damage	0,294
Severely Damage	0,506
Amount	**1,000**

Tabel 2 explains the road condition factors. It shows the weight for good road conditions is 0.060 (6%),

moderate damage road conditions is 0.139 (13.9%), mildly damaged road conditions is 0.294 (29.4%) and heavily damaged road conditions is 0.506 (50.6%). This shows that the highest priority weight is on heavy damaged road conditions with a value of 0.506 (50.6%).

3.3. Land Use Factor Analysis

Table 3: Land Use Factor

Factor	Weight
Agriculture	0,040
Education	0,185
Industry	0,106
Trade	0,102
Tourism sector	0,321
Residential area	0,133
Office	0,113
Amount	**1,000**

From Table 3, it is explained that the Land Use weighs differently. The weight of Agriculture is 0.040 (4%), Education is 0.185 (18.5%), Industry is 0.106 (10.6%), Trade is 0.102 (10.2%), the Tourism sector is 0.321 (32.1%), the Residential area is 0.133 (13.3%), and the Office is 0.113 (11.3). This shows that the highest priority weight is on the Tourism sector with a value of 0.321 (32.1%).

3.4. Connectivity Factor Analysis

Table 4: Road Connectivity Factor

Factor	Weight
Primary Collector 4 (JKP – 4) strategic Road	0,278
Primary Collector Road 4 (JKP – 4) from the district capital to the capital of the subdistrict	0,241
Primary local road (JLP) between the PKL	0,139
Primary local road (JLP) strategic Road	0,103
Primary local road (JLP) between PKL and PK-Ling	0,078
Primary Environmental Road (JLingP) between PK-Ling and Persil	0,056
Secondary arterial road (JAS)	0,027
Secondary collector road (JKS)	0,026
Secondary local road (JLS)	0,026
The secondary Environmental Road (JLingS)	0,026
Amount	**1,000**

Table 4 explains the connectivity factor weight of the roads. For primary collector road 4 (JKP-4) strategic road, the weight is 0.278 (27.8%). Primary collector road 4 (JKP-4) from Regency Capital to District Capital is 0.241 (24.1 %). Primary local roads (JLP) between PKL is 0.139 (13.9%). Primary local roads (JLP) strategic roads is 0.103 (10.3%), primary local roads (JLP) between PKL and PK-Ling is 0.078 (7.8%), primary environmental road (JLingP) between PK-Ling and Persil is 0.056 (5.6%), secondary arterial road (JAS) is 0.027 (2.7%), secondary collector road (JKS) is 0.026 (2.6 %), secondary local roads (JLS) is 0.026 (2.6%) and secondary neighbourhood roads (JLingS) is 0.026 (2.6%). This shows that the highest priority weight is on primary collector road 4 (JKP-4) which is a strategic road with a value of 0.278 (27.8%).

3.5. Traffic Volume Factor Analysis

Table 5: Traffic Volume Factor

Factor	Weight
< 50 pcu/ hour	0,069
51-200 pcu/ hour	0,108
201 – 500 pcu/ hour	0,258
> 500 pcu/ hour	0,565
Amount	**1,000**

From Table 5, it is explained that the Traffic Volume factor shows the priority weight for traffic volume <50 pcu / hour is 0.069 (6.9%). Traffic volume 51-200 pcu / hour is 0.108 (10.8%). Traffic volume 201 - 500 pcu / hour is 0.258 (25.8%) and traffic volume> 500 pcu / hour is 0.565 (56.5%). This shows that the main priority weight is of traffic volume> 500 pcu / hour 0.565 (56.5%).

3.6. Policy Factor Analysis

Table 6: Policy Factor

Factor	Weight
Musrenbang Village	0,105
Musrenbang Subdistrict	0,258
Musrenbang District	0,637
Amout	**1,000**

Table 6 explains the different priority weight parameters for village Musrenbang 0.105 (10.5%), sub-district Musrenbang 0.258 (25.8%), and district Musrenbang 0.637 (63.7%). This shows that there is a main priority weight on the district Musrenbang 0.637 (63.7%).

3.7. Analysis of Case Studies on Road Sections Argosari-B29, Wonokerto-Wonosari, Kalimas and Senduro-Ranupane

This case study was conducted on road segments representing examples of case studies relating to road conditions, land use, connectivity, traffic volume and existing policies in Lumajang Regency. It was based from work which had previously been done such as surveys related to these research criteria. In this case study, it discusses the priority of road maintenance to be conducted on the roads of Argosari-B29, Wonokerto-Wonosari, Kalimas and Senduro-Ranupane, derived from Figure 3.

Priority = the result from multiplication criteria weight value (Nilai Kriteria - NK) with sub-criteria weight value (Nilai Sub-kriteria - NS).

No.	Section Road	Criteria																	Priority
		Road Condition = 0,328		Result	Land Use = 0,119		Result	Road Connectivity = 0,166		Result	Traffic Volume = 0,138		Result	Policy = 0,250		Result	Amount		
		Sub Criteria	Weight		Sub Criteria	Weight		Sub Criteria	Weight		Sub Criteria	Weight		Sub Criteria	Weight				
a	b	c	d	f = (0,328 x d)	g	h	i = (0,119 x h)	j	k	l = (0,166 x k)	m	n	o = (0,138 x n)	p	q	r = (0,250 x q)	s = (f + i + l + o + r)		t
1.	Argosari - B29	Severely Damage	0,506	0,166	Tourism	0,321	0,038	Primary local road (JLP) between PKL and PK-Ling	0,078	0,013	<50 pcu/hour	0,069	0,009	Muarambang District	0,637	0,159	0,386		1
2.	Wonokerto - Wonosari	Severely Damage	0,506	0,166	Agriculture	0,040	0,005	Primary local road (JLP) between PKL and PK-Ling	0,078	0,013	<50 pcu/hour	0,069	0,009	Muarambang District	0,637	0,159	0,352		2
3.	Kalimas	Moderate	0,139	0,046	Education	0,185	0,022	Secondary collector road (JKS)	0,026	0,004	51-200 pcu/hour	0,108	0,015	Muarambang Subdistrict	0,258	0,065	0,151		4
4.	Senduro - Ranupane	Mild Damage	0,294	0,097	Tourism	0,321	0,038	Primary local road (JLP) between the PKL	0,139	0,023	51-200 pcu/hour	0,108	0,015	Muarambang Subdistrict	0,258	0,065	0,237		3

Figure 3: The results of the weight determination on the road sections Argosari-B29, Wonokerto-Wonosari, Kalimas

The figure above shows :

1. Road section Argosari – B29

a. Road conditions (NK = 0.328)

Included in heavy damaged road conditions (NS = 0.506)

Result = NK x NS = 0.328 x 0.506 = 0.166

b. Land Use (NK = 0.119)

Included in tourism field (NS = 0.321)

Result = NK x NS = 0.119 x 0.321 = 0.038

c. Connectivity (NK = 0.166)

Included in primary local road (JLP) between PKL and PK-Ling (NS = 0.078)

Result = NK x NS = 0.166 x 0.078 = 0.013

d. Traffic Volume (NS = 0.136)

Included in traffic volume < 50 SMP/hr (NK = 0.069)

Result = NK x NS = 0.136 x 0.069 = 0.009

e. Policy (NK = 0.250)

Included in Musrenbang district policy (NS = 0.637)

Result = NK x NS = 0.250 x 0.637 = 0.159

It can be explained that from the section of Argosari-B29, Wonokerto-Wonosari, Kalimas dan Senduro-Ranupane, the road section that is the main priority is Argosari – B29. The second is road section Wonokerto – Wonosari. The third is road section Senduro – Ranupane and the fourth is road section Kalimas. From the discussion above, it is possible to apply this study as a reference for determining the priorities and follow up of management and maintenance in the development of the roads.

4. Conclusion

The first and main priority in road maintenance in the Lumajang Regency is mainly viewed from its "condition" with a value of 0.328 (32.8%). Secondly, it is viewed from to the "policy" factor with a value of 0.25 (25%). Thirdly, it is viewed from the "connectivity" factor with a value of 0.166 (16.6%). Fourthly, it is from the "traffic volume" factor of 0.136 (13.6%) and lastly it is viewed from the "land use" factor with a value of 0.119 (11.9%). For the main priorities, the study shows the most influential factors in the maintenance of roads are:

a. Road Condition

Road condition is severely damaged with a value of 0.506 (50.6 %).

b. Land Use

Tourism with a value of 0.321 (32.1%).

c. Road Connectivity

Primary Collector Road 4 (JKP – 4) strategic road with a value of 0.278 (27.8%)

d. Traffic Volume

Traffic Volume > 500 pcu/hour 0.565 (56.5%).

e. Policy

Musrenbang District 0,637 (63,7%).

The case study of 4 (four) road sections (Argosari-B29, Wonokerto-Wonosari, Kalimas and Senduro-Ranupane) shows that the first priority is the road section Argosari-B29, the second is the road section of Wonokerto-Wonosari, the third is the road section Senduro-Ranupane and fourth is the road section Kalimas. With this study, a follow up in road construction and maintenance could be conducted.

Acknowledgements and Recommendations

-silahkan dimasukkan appresiasi-

-Silahkan masukkan rekomendasi-

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