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Analysis of Priority Scale of Road Handling In Murung Raya Regency Using Analytical Hierarchy Process (AHP) Method

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Abstract: *Prioritization of road handling is very necessary in supporting the equalization of road infrastructure construction to fulfill the public needs of the people of Murung Raya Regency. In the present study, the reviewed criteria were non-technical criteria (development planning deliberation, public proposal, special policy and fund availability) and technical criteria (road class, Average Daily Traffic (LHR), road damage, terrain, road function and land use). The purpose of this study was analyzing the criteria which affected the prioritization of road handling. The data analysis used Wilcoxon rank-test to measure the level of significance of the data of questionnaire result and Analytical Hierarchy Process (AHP) method to determine the prioritization of road handling. Based on AHP analysis, technical criteria (road class, Average Daily Ttaffic (LHR), damage level, terrain, road function and land use) which scores 85.71%, higher than non-technical factors (development planning deliberation, public proposal, special policy and fund availability) which scores 14.29%. The road damage sub-criteria (severe, moderate and mild) scores 40.05% as a very influential element, while land use sub-criteria (protected zone, commercial zone, office zone, industrial zone, residential zone, productive zone and non-productive zone) scores 4.2% was the sub-criteria with the lowest effect.*

Keywords: Road handling, reviewed criteria, AHP method

I- INTRODUCTION

The government of Murung Raya Regency has made many efforts to implement regional autonomy as well as possible, including repairing road infrastructure. Based on the Decision of Murung RayaRegency number 188.45/150/2016 on the Establishment of Roads by Their Status as Regency Roads, there are 173 regency roads, with total road length of 919,54 km which is spread in 10 (ten) sub-districts[1]. Murung Raya Regency is split from North Barito Regency [2].

During the course of development in Murung Raya Regency, there should be equalization of development in all fields, requiring supporting factors such as stable and maintained roads. Currently, in determining road construction plan, Department of Public Work and Spatial Layout performs regular field survey every year and submits activity proposals through development planning deliberation (*musrenbang*), i.e. from village development planning deliberation, sub-district development planning deliberation, to regency development planning deliberation, but often misses the targets and neglects technical criteria, benefit and cost. Due to the complexity of the problems in the field, which are affected by aspects such as: road damage, average daily traffic (LHR), terrain, road function, and regional development? Therefore, a method which can accommodate all of the aspects and anticipate gaps is necessary. One of the methods which can be used by decisions makers is Analytical Hierarchy Process (AHP) which is often used to help in decision making, including prioritization of road handling.

2. LITERATURE REVIEW

2.1 Definition of road

The definition of road is the whole section of a street, including the complementary constructions for public traffic which is below the ground, above the ground, under the water surface, and above the water surface, except for railway and cableway [3]. Road drives the

development of all development area units to enhance regional development. Road classifications by function are arterial road, collector road, local road, environmental road [4][5]. To regulate road use and fulfill the needs of motorized transportation, road is divided into several classes, i.e. Class I Road, Class II Road, Class III Road, Special Class Road [6].Road classifications by terrain for geometric planning areplain, hill and mountain [7].Meanwhile, the categories of road damage are severely damage, moderately damaged, and mildly damaged [8]

2.2 Wilcoxon Test

The AHP comparison assessment scale is made based on the categorization or classification of the level of importance and existence of relation between data. Data with wide distribution of answer has better median than modus because median still considers all answers. The median selected to be the value which can represent the preferences of all respondents is obtained using nonparametric tests, such as signed test or Wilcoxon-signed rank test [9][10].Wilcoxon test evaluates the shift in distribution of difference to the right or left of the original median value or original hypothesis value (θ). The null hypothesis (Ho) is median value which is equal toθ,while alternative hypothesis (Ha) is median value which isn't equal to θ. Ho is rejected if the P-value is smaller than the set significance value (α).Specific value of α for one direction can use0.05, 0.025, 0.01 or 0.005 and for two ways can use0.1, 0.05, 0.02, or 0.01. P-value is obtained from t-distribution with standardized test statistic (z) value from Wilcoxontest [11].

2.3 Processes in Analytical Hierarchy Process (AHP) Method

The processes in AHP method are as follows [12][13] :

1. Defining problem and determining the desired solution.
2. Making hierarchal structure which starts from general purpose, followed by criteria and alternative possibilities at the lowest level of criteria.
3. Making paired comparison matrix which describes relative contribution or the effect of every element on the criterion above.
4. Making paired comparison to obtain x ((n-1)/2) judgments (decisions), with n being the number of compared elements.
5. Calculating eigen value and testing its consistency. If not consistent, then data collection is repeated.
6. Repeating steps 3,4 and 5 for every level of hierarchy.
7. Calculating eigenvector of every paired comparison matrix.
8. Checking the consistency of the hierarchy. If the value is more than 10 percent, then data judgment must be improved.

The data analysis framework with Analytical Hierarchy Process (AHP) is presented in Figure2.

3. RESEARCH METHOD

3.1 Research flow

The research procedure followed the following flow:

1. Research background which is the importance of objective and accurate research on the analysis of priority scale of road handling using AHP method in Murung Raya Regency.
2. Formulation, purpose, limitation and benefit of research.
3. Literature review is necessary to understand the theoretical basis which supports the purpose to be achieved in the study
4. Formulation of methodology is necessary to determine the research stages.
5. Arranging hierarchy to design the desired hierarchal structure for the present study and to prepare questionnaire questions for respondents.
6. Collecting data from related departments, such as Department of Public Work and Spatial Layout, Regional Development Planning and Development Research Agency, Consulting supervisor/planner, Housing and Settlement Department, and Development Administration section of the Regional Secretary of Murung Raya Regency
7. Processing and analyzing the data using Analytical Hierarchy Process (AHP) and Wilcoxon Signed-Rank Test which were selected from various referenced literatures.
8. Concluding research results and making recommendations.

3.2 Data Collection

The data collected in the present study consisted of primary data and secondary data.

1. Primary data, collected from a survey using questionnaire and interview methods on respondents in Department of Public Work and Spatial Planning, Regional Development Planning and Development Research Agency, Consulting supervisor/planner, Housing and Settlement Department, and

Development Administration section of the Regional Secretary of Murung Raya Regency.

2. Secondary data, collected from Department of Public Work and Spatial Planning and Regional Development Planning and Development Research Agency.

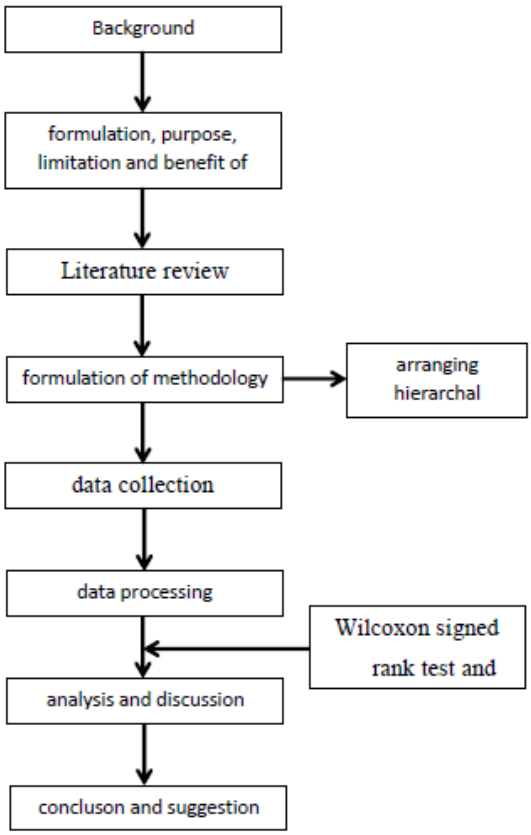

Fig.1-The research flow is presented

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2. Secondary data, collected from Department of Public Work and Spatial Planning and Regional Development Planning and Development Research Agency.

3.3Hierarchy Formation

This section introduces a conceptual approach to determine the priority scale of road handling using Analytical Hierarchy Process (AHP) method. There were 5 (five) proposed levelsof hierarchy as presented in Figure3 They are:

Level 1.The first level described the target of the decision to be made which was at the top of the hierarchy and also the main purpose of this study, i.e. determining the priority scale of road handling.

Level 2.The second level consisted of2 choices based on technical and non-technical criteria which were reviewed in determining the priority scale of road handling.

Level 3.The third level submitted assessment sub criteria of technical and non-technical criteria. Technical criteria was categorized into road class, ADT, road damage, terrain, road function and land use. Nontechnical criteria were categorized into development planning deliberation, public proposal, special policy and fund availability.

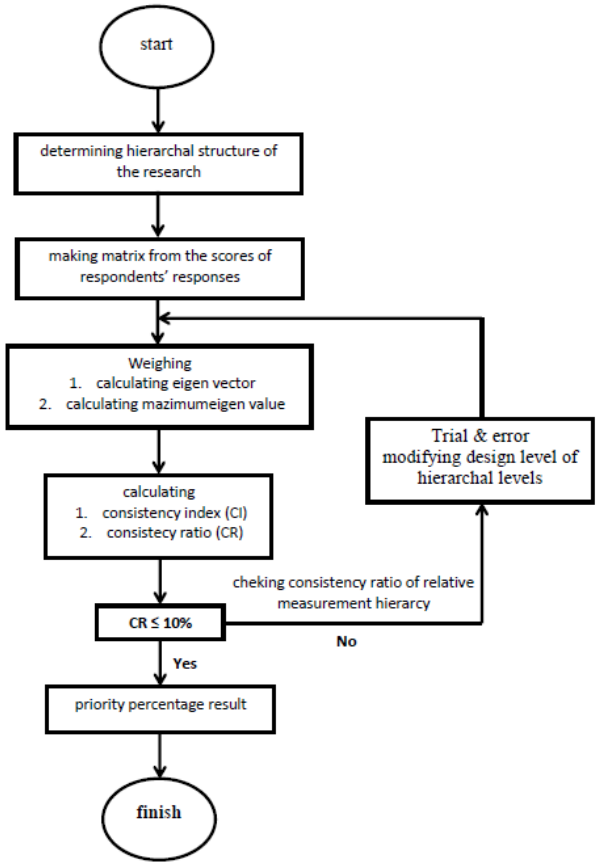

Fig 2- Data Analysis Framework with AHP Method

Level 4.The fourth level submitted assessment sub criteria road class, ADT, road damage, terrain, road function and land use. Road class was categorized into class I road, class II road, class III road and special class road. Road ADTwas categorized by average daily traffic which were < 2000, 2000 – 19,500, 19,500-27,100, 27,100-72,900, 72,900-109,400 and 109,400-145,900.Road damage was categorized by road damage, i.e. mild damage, moderate damage, and severe damage. Terrain was categorized by terrain condition, i.e. plain, hill and mountain. Road function was categorized into arterial road, collector road, local road, and environmental road. Land use was categorized by the

land use around roadside. Protected zone, commercial zone, office zone, industrial zone, residential zone, productive zone and non-productive zone.

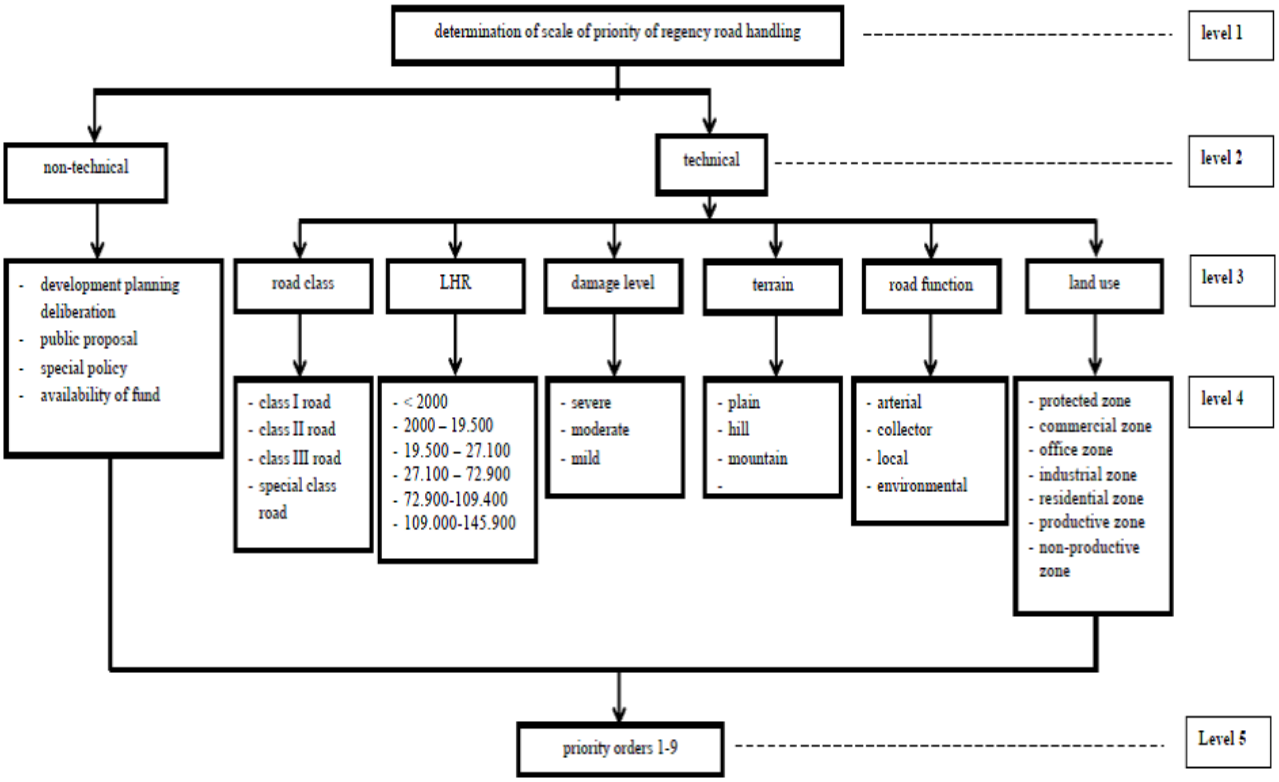

Fig 3- Hierarchal structure of AHP of determination of scale of priority of road handling

4. RESULT AND DISCUSSION

4.1 Background of respondents

The respondents must have ability/skill in road management.

Research survey was performed by distributing questionnaires to respondents in Department of Public Work and Spatial Layout, Regional Development Planning and Development Research Agency, Development Section of the Regional Secretary of Murung Raya Regency and Consulting planner/supervisor.

Table1-Research respondents

No	Scope of Respondent's Occupation	Total Respondents
1.	Department of Public Work and Spatial Layout	17
2.	Regional Development Planning and Development Research Agency	2
3.	Development Section of Regional Secretary	2
4.	Department of Housing and Settlement	4
5.	Consultant	4
Total		29

Of 33 distributed questionnaires, 29 questionnaires were returned. The data collected by questionnaire was then analyzed and discussed. Descriptive analysis was presented as additional information to understand the result of the current study and describe the respondents' answers to the questions in the questionnaires.

1. Final education

The final education of the research respondents was classified into 2 (two), i.e. undergraduate and graduate. Respondents with higher education better understood the assessment of every question. Based on the result of the questionnaire survey, of the 29 respondents, 17% had undergraduate education and 83% had graduate education as shown in Figure 4.

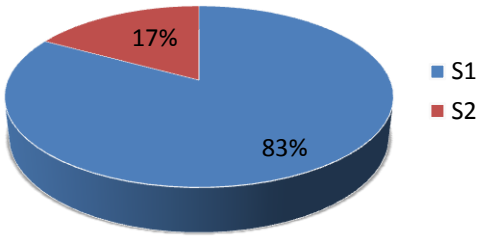

Fig- 4 -Final Education of Respondents

2. Work experience

Respondents' work experiences in the present study were classified into 3 (three), i.e.less than 10 years, 10-20 years and more than 20 years. Respondents with more work experiences better understood the assessment of every question. Based on the result of the questionnaire survey, of the 29 respondents, 17% had more than 20 years of work experience, 52% had 11-20 years of work experience and 31% had 1- 10 years of work experience. This is shown in Figure5.

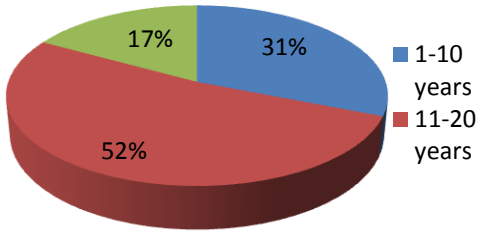

Fig 5- Work Experiences of Respondents

4.2 Determination of Weight of Element

At this stage, every element in the AHP hierarchal structure in Figure 3.3 was weighed.For example,the weight of element at level-3 (4x4matrix) was determined from the scores of answers of questions number 2 (two) to 7 (seven) in the nontechnical criteria, i.e.development planning deliberation, public proposal, special policy and availability of fund. It's presented in Table2.

Table2-Respondents' Answers for Level-3Paired Matrix

No.	Question		Median of Hypothesis
	Origin	Recipient	
1	development planning deliberation	public proposal	4
2	development planning deliberation	special policy	5
3	development planning deliberation	availability of fund	4
4	public proposal	special policy	5
5	public proposal	availability of fund	2
6	special policy	availability of fund	1/3

Assessment matrix was then made to calculate MG value, perform weighting, calculateeigen value, calculate maximumeigenvalue, and lastly calculate ratio of consistency. If the ratio which is bigger than the acceptable value (Cr>10%), means the process should be repeated because the matrix wasn't consistent enough. The resulting matrix and analysis are presented in Table3.

Table3 Level-3 Paired Matrix of Nontechnical Criteria (4x4 Matrix)

sub criteria	development planning deliberation	public proposal	special policy	availability of fund	**Mg**	**Weight**	**Eigen Value**
development planning deliberation	1.00	4.00	5.00	4.00	2.99	0.557	2.39
public proposal	1/4	1.00	5.00	2.00	1.26	0.234	0.98
special policy	1/5	1/5	1.00	0.33	0.34	0.063	0.27
availability of fund	1/4	1/2	3.00	1.00	0.78	0.146	0.59
					5.37	**1.00**	**4.24**

From calculation, Ci = 0.08; Ri = 0.9; Cr = 8.73 %; Cr < 10%, so if Cr 8.73% < 10%, then the result of the calculation of the ratio of consistency of questions 2 (two) to 7 (seven) was acceptable.

4.3 Normalization of element weighing

Then, every element was normalized to get priority percentage. The calculation of normalization of level-3 elements of non-technical criteria is below:

The calculation of nontechnical criteria weighing produces 14.29%

Value $_{\text{development planning deliberation}}$ = 14.29% x 0.5569 = 7.96%

Value $_{\text{public proposal}}$ = 14.29% x 0.2341 = 3.34%

Value $_{\text{special policy}}$ = 14.29% x 0.0633 = 0.90%

Value $_{\text{availability of fund}}$ = 14.29% x 0.1457 = 2.08%

Table4 - Result of Normalization of Level-3 of Nontechnical Criteria

Sub-criteria	Weight	Normalization Result
development planning deliberation	0.56	7.96%
public proposal	0.23	3.34%
special policy	0.06	0.90%
availability of fund	0.15	2.08%
	1.00	**14.29%**

After normalization was performed, it was found that development planning deliberation had a value of 7.96% which was the highest value. Public proposal had a value of3.34%, availability of fund 2.08% and special policy0.9%, which was the lowest value, as shown in Table 5.

In a previous study to determine the priority scale of road management, the factors affecting weighing in AHP method on the priority ranks of road management in Banjarmasin are technical and nontechnical factors. The weight of the technical factor is75%, more influential than nontechnical factors which weighed 25%. However, overall, in terms of fulfillment of nontechnical indicators, the most important factories Development Planning Meeting(14.48%). The most important technical aspect in terms of maintenance and repairare severe damage 8.63% in maintenance and8.53% in repair [14].

The present study aimed to determine the scale of priority of road handling using AHP method on Regency. The weight of technical factors was 85.71%, higher than nontechnical factors which weighed14.29%. Road damage which weighed40.05% was very influential compared with development planning deliberation which weighed 7.96 %.

4.4 Implementation

4.4.1 The compared roads

Based on the work plan proposal of the Department of Public Work and Spatial Layout, some streets were proposed to be repaired in 2018 fiscal year, as shown in Table6.

Table6 Compared roads

No.	No. of road	Reviewed Road	Road length (km) based on the Decree of the Regent
1	1	Jl. Jend. A Yani	4,00
2	5	Jl. Ki HajarDewantara.	0,85
3	24	Jl. A H Nasution.	2,50
4	32	Jl. Diponegoro	3,00
5	62	Jl. Puruk Cahu - Dirung Bakung	10,00
6	77	Jl. Kerali – Belawan – Kalang Kaluh	9,40
7	87	Jl. Kolam - Saruhung	6,00
8	89	Jl. Cangkang - Nonokliwon	13,00
9	99	Jl. HPH-Bana/Narui	13,50

4.4.2 Weighing roads compared with AHP

Road was weighed by calculating the normalized weight of level 4 elements compared with the weight of the survey on the roads proposed by the Department of Public Work and Spatial Planningin 2018fiscal year. For example, in the weighing ofPurukcahu – DirungBakung road, the weights of the assessed elements were class III road 2.6%, ADT<2000 0.56%, severely damaged 25.1%, mildly damaged 3.75%, plain 2.66%, hill 4.23%, local road 2.56%, residential zone 1.08%, productive zone 0.44% and development planning deliberation 7.96%, so the weight ofPurukCahu – DirungBakungroad was:

$$\begin{aligned} Weight\ of\ road \\ &= (2.6\% \times 100\%) \\ &+ (0.56\% \times 100\%) \\ &+ (25.1\% \times 80\%) + (3.75\% \times 20\%) \\ &+ (2.66\% \times 20\%) + (4.23\% \times 80\%) \\ &+ (2.56\% \times 100\%) + (1.08 \times 30\%) \\ &+ (0.44\% \times 70\%) + (7.96\% \\ &\times 100\%) = 39.05\% \end{aligned}$$

From the calculations ofthe 9 (nine) proposed roads, the weight of each road was found. The roads were Jl. Jend. A Yaniwhich weighed 13.93%, Jl. Ki HajarDewantarawhich weighed 13.99%, Jl. A.H Nasutionwhich weighed 16.76%, Jl. Diponegoro

16.10%, Jl. PurukCahu - DirungBakungwhich weighed 39.05%, Jl. Kerali – Belawan – KalangKaluhwhich weighed 35.19%, Jl. KolamSaruhungwhich weighed 39.61%, Jl. Cangkang – Nonokliwonwhich weighed 41.96%.

Table5-Recapitulation of the Result of Normalization of Criteria and Sub Criteria

Level-1 (target)		**Level-2 (criteria)**		**Level-3 (Sub criteria)**		**Level-4 (Sub criteria)**	
Attribute	**Weight**	**Attribute**	**Weight**	**Attribute**	**Weight**	**Attribute**	**Weight**
Determination of Scale of Priority of Regency Road Handling	100%	Technical	85,71 %	road class	4.95%	class I road	0.77%
						class II road	1.17%
						class III road	2.60%
						special class road	0.40%
				ADT	15.27%	<2000	0.56%
						2000-19500	0.88%
						19500-27100	1.26%
						27100-72900	2.17%
						72900-109400	4.09%
						109400-145900	6.31%
				damage level	40.05%	severe	25.10%
						moderate	11.20%
						mild	3.75%
				terrain	13.60%	plain	2.66%
						hill	4.23%
						mountain	6.71%
				road function	7.64%	arterial road	0.67%
						collector road	3.04%
						local road	2.56%
						environmental road	1.37%
				land use	4.20%	protected zone	0.20%
						commercial zone	0.52%
						office zone	1.49%
						industrial zone	0.33%
						residential zone	1.08%
						productive zone	0.44%
						non productive zone	0.14%
		Non Technical	14,29 %	development planning deliberation	7.96%		
				public proposal	3.34%		
				special policy	0.90%		
				availability of fund	2.08%		

The AHP analysis of road handling priority and road handling priority by the local government of the roads weight and collected data of the survey on the roads to be reviewed were compared. It's presented in Table 4.8

Table7Comparison of AHP Analysis Result and Proposal of Department of Public Work and Spatial Planning

No.	No of road	Road name	Weight of road (%)	Scale of priority	Proposal of Department of Public Work and Spatial Planningin DPA 2018
1	99	Jl. HPH-Bana/Narui	44.43%	1	performed
2	89	Jl. Cangkang - Nonokliwon	41.96%	2	performed
3	87	Jl. Kolam - Saruhung	39.61%	3	performed
4	62	Jl. Puruk Cahu - Dirung Bakung	39.05%	4	performed
5	77	Jl. Kerali - Belawan	35.19%	5	performed
6	24	Jl. A H Nasution.	16.76%	6	not performed
7	32	Jl. Diponegoro	16.10%	7	not performed
8	5	Jl. Ki HajarDewantara.	13.99%	8	not performed
9	1	Jl. Jend. A Yani	13.93%	9	not performed

As shown in Table7, compared with prioritization by the Department of Public Work and Spatial Planning, the result of AHP showed the same rank. It was evident in roads number 1 (one) to 5 (five) which were the random top priorities in AHP analysis method. Meanwhile, the roads which weren't worked on were randomly ranked lowest in AHP analysis method. The condition showed that the prioritization of road handling using AHP method was applicable.

5. CONCLUSION

Based on AHP analysis method, the technical criteria (road class, ADT, damage level, terrain, road function and land use) had a value of 85.71%, higher than nontechnical criteria (development planning deliberation, public proposal, special policy and availability of fund) with a value of 14.29%. Road damage (severe, moderate and mild) had a value of 40.05% which was the highest effect, while land use (protected zone, commercial zone, office zone, industrial zone, residential zone, productive zone and non-productive zone) had a value of 4.2% which was the lowest effect.The result of comparison between AHP method and implementation of government suggestion on road handling showed similar decision.Works which had been performed an hand't been performed were consistent with the weighing priorities, showing that AHP method could be applied in determining the priority scale of road handling inMurung Raya Regency.

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