The Determination of Priority Scale for City Road Management in Banjarmasin

Damayanti[#1], Iphan F Radam[*2]
[#]*Graduate Student of Transportation Engineering and Management, Magister Study Program of Civil Engineering, Lambung Mangkurat University, Banjarmasin, Indonesia*
[*]*Associate Professor, Study Program of Civil Engineering, Lambung Mangkurat University, Banjarmasin, Indonesia Graduate*

Abstract

The road management priority is needed by decision makers in serving public necessities in terms of accomplishment of equitable road infrastructure. In this research, the method used did not only have particular regard for non-technical factor which consisted of Development Plan Meeting (Musrenbang), public proposal, and policy, but also for technical factors. Technical factors were reviewed in terms of its management, namely the maintenance and improvement, each of which consisted of Average Daily Traffic (LHR), damage level, road network, land use, road function, and road class. The present research was aimed to obtain the priority rank of road management, by considering the factors that influenced the analysis using the AHP method. Based on the results of the AHP analysis, the factors that influenced the weighting in the AHP method towards the priority rank of road management in the City of Banjarmasin in this research are technical and non-technical factors. As for technical factors, they have 3 (three) times weight (75%) from that of non-technical factors' (25%). However, in overall, judging from the fulfillment of non-technical indicators, they apparently have a massive weight: the most important factor is shown by Development Plan Meeting with a weight of 14.48%. As for the technical aspects, both for maintenance and improvement, they are shown by severe damage indicator with an interest level of 8.63% in terms of maintenance, and 8.53% for improvement. The usage of the AHP method in determining the priority scale of road management is applicable to the role and commitment of the decision makers.

Keywords — *AHP, priority scale, city roads.*

I. INTRODUCTION

The preparation of the priority rank for road management in the City of Banjarmasin is under influence of various aspects, including the results of Development Plan Meeting, policy, public aspiration, road condition, land use, and available budget. Nevertheless, in its preparation, it is yet to use analytical methods. In order to see whether the priority determination of road management in the city of Banjarmasin has described the public needs well, a research is necessary to assess the priority scale for road management in the City of Banjarmasin, using the Analytical Hierarchy Process (AHP) method. The analysis of priority scale determination of road management from the AHP method is expected to obtain a more representative conclusion that can be used in determining the priority scale of road management in the city of Banjarmasin in the future. The objectives of this research are:

1. Analyzing the priority rank of road management in the City of Banjarmasin by considering the factors that influence the weighting in the AHP method.
2. Comparing the priority rank of road management in the City of Banjarmasin based on the AHP method and the existing management.

II. LITERATURE REVIEW

Roads are land transportation infrastructure that includes all parts of the road, which consist of complementary buildings and their equipment intended for traffic, are located on the ground surface, above the ground level, below ground level and/ or water, and above the water, with exception of railways, lorry roads and cable roads. According to the system, they are consisted of primary road networks and secondary road networks. According to its function, they are classified into arterial roads, collector roads, local roads, and environmental roads. According to their status, they are grouped into national roads, provincial roads, regency roads, city roads, neighborhood roads and village roads [1]. For the regulation of road usage and smooth traffic, the distribution of road classes is regulated according to the laws and regulations in the field of traffic and road transportation, consisting of Class I Road, Class II Road, Class III Road, and Special Class Road [2]. Road network management program includes road maintenance program, road improvement program, and new road construction program [3]. Spatial structure is the composition of settlement centers and the network infrastructure and facilities system functioning as a supporter of the socio-economic activities of the community that are hierarchically functional [4]. The spatial pattern is the distribution of the designation of space in an area which includes spatial designation for preservation and spatial allocation for cultivation [5]. As for data with a wide distribution of answers, the median value will be

better than the mode, as the median value still considers all answers. The median value selected as a value that can represent the preferences of all respondents is obtained using Wilcoxon-marked rank test [6]. Previous study that has applied this test is [7]. The Wilcoxon-marked rating test (Wilcoxon test) was introduced by Frank Wilcoxon in 1945 with these assumptions: (a) the sample was randomly selected from the population it represented; (b) the score obtained by each object was made into interval or ratio data format; and (c) the distribution of the underlying population was symmetrical against the median value; otherwise, mean values were also usable [8], [9]. AHP is a method of analysis and synthesis that can assist the decision making process in establishing priorities, where qualitative and quantitative aspects are involved and both must be considered [10]. The use of AHP is begun by creating a hierarchical or network structure of the problems under study [11]. Hierarchy is defined as a representation of a complex problem in a multi-level structure, in which the first level is the objective, followed by the level of factors, criteria, sub-criteria, and so on down to the last level of alternatives [12]. AHP calculates the validity up to the tolerance limit for the inclusion of various criteria and alternatives selected by the decision makers [13]. AHP measurement method can be divided into 2 (two) measurement methods: Relative Measurement Method/ RMM and the Absolute Measurement Method (AMM) [14; 15]. Geometric mean calculation is used in AHP for survey results with a relatively large number of samples for pairwise comparison of each respondent [16]. Previous studies have applied the AHP method by combining various factors to obtain the importance level, where with the weight of each criterion is used to determine the priority scale of road management [17], [18], [19], [20].

III. METHODS

A. Research Stages

The present research was conducted with these following stages:

- Identifying and collecting the data
- Conducting an interest level survey using the AHP method
- Arranging hierarchical structure
- Arranging section design research
- Assessing road section for each criterion
- Determining selected alternatives

The flowchart of this research is illustrated in Fig. 1. The process of weighting and determining the hierarchy is shown in Fig. 2.

B. Selection of Respondent

The selection of respondents is based on consideration under the requirements of having knowledge and competence in the field of road management. The respondents selected can be seen in Table 1.

C. Data Collection Method

1) Filling-out Questionnaires

This method was done by distributing questionnaires to respondents to fill out.

2) Collection Data from Agencies

The method conducted was in the form of data collection obtained from agencies related to this research.

- Data on road maintenance management and road improvement of 2018, Mayor of Banjarmasin's Decree on the status determination of city roads in Banjarmasin [21], and basic road data (*Data Dasar 1*/DD1) of 2018 from the Office for Public Works and Spatial Planning of Banjarmasin.
- City of Banjarmasin's spatial planning [22] from City of Banjarmasin's Regional Research and Development Planning Agency.

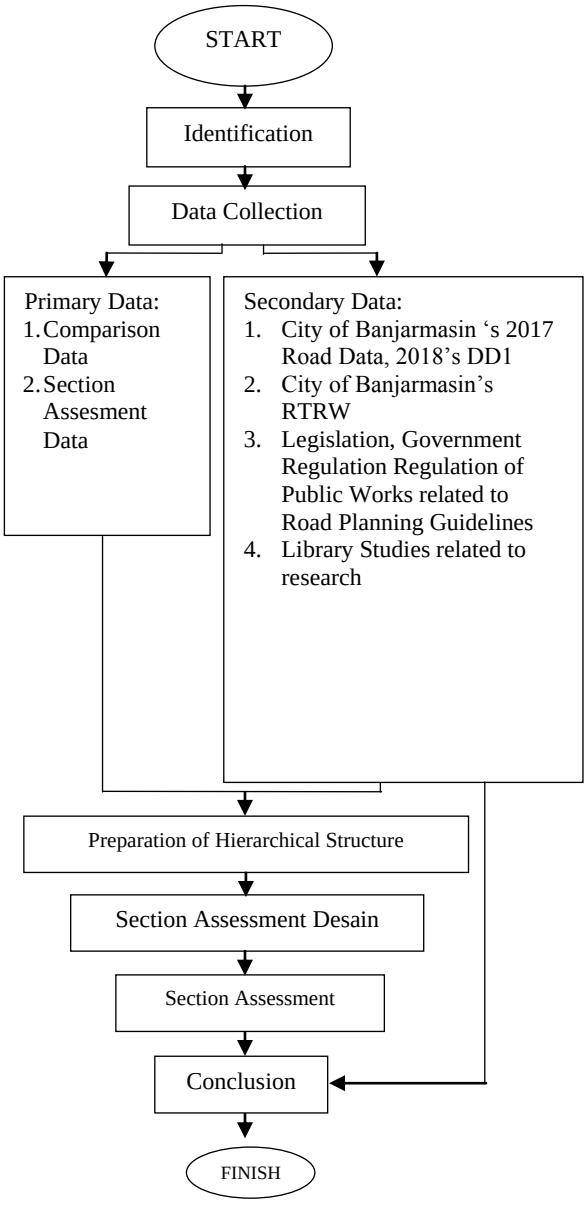

Fig 1: Research Flow Chart

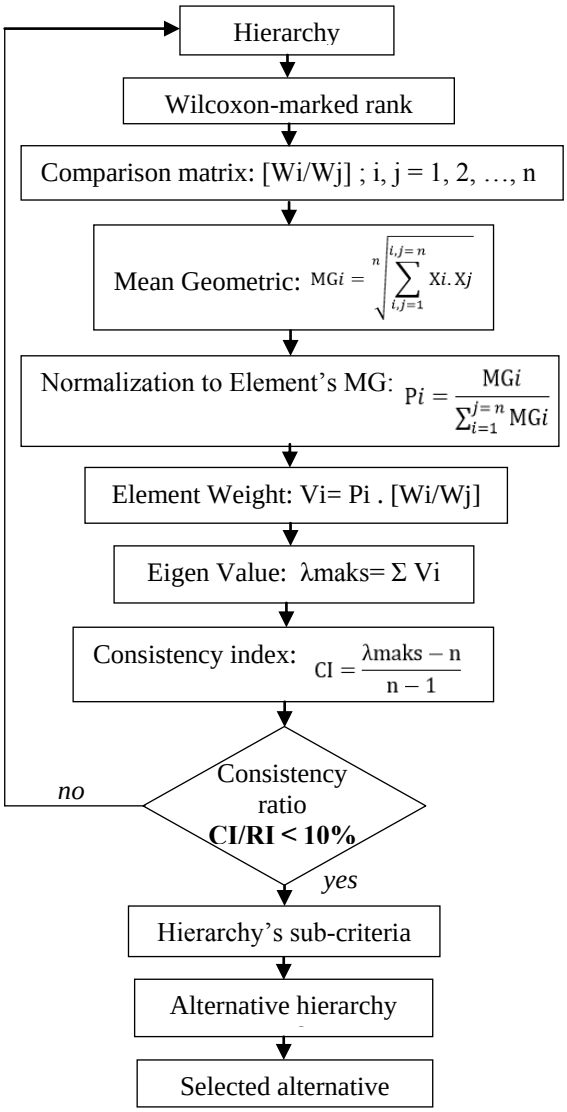

Fig 2: Process of Weighting and Determining the AHP Hierarchy

TABLE I
Distribution of Respondents for AHP Samples

No.	Stakeholder	Respondents
1	Public Works and Spatial Planning Office of Banjarmasin	19
2	Regional Planning, Research and Development Office of Banjarmasin	10
3	Public Works and Spatial Planning Office of Banjarbaru	15
4	Practisioner	3
5	Academics	2
	Total	49

D. Usage Stages of AHP Method

1) The Arrangement of Hierarchical Level

The arrangement of hierarchical level was followed by creation of questionnaire design to compare the importance level towards the objectives in pairs on each criteria level element and sub-criteria.

2) Data Processing Process

The data processing process using the AHP method in this research was begun by entering questionnaire data from the respondents, analyzing the median using the Wilcoxon-marked rank test, which was then continued using SPSS (Statistical Package for the Social Sciences) software tool [7], weighting calculation, calculating maximum eigen value, and performing consistency tests. The final stage was the priority scale calculated using a mathematical model.

IV. RESULT AND DISCUSSION

A. Identity of AHP Respondents

Respondents' identity based on gender type in this research is shown in Fig. 3.

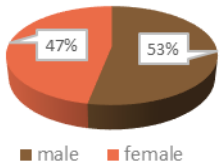

Fig 3: Respondents' Identity Based on Gender Type

Respondents' identity in this research is viewed from the level of education in Fig. 4.

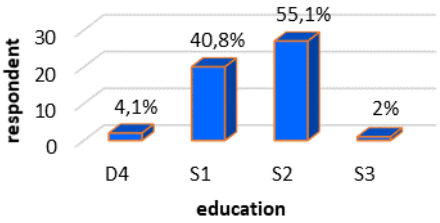

Fig 4: Respondents' Identity Based on Education Level

The respondents' identity based on the duration of work experience in this research is shown in Fig. 5.

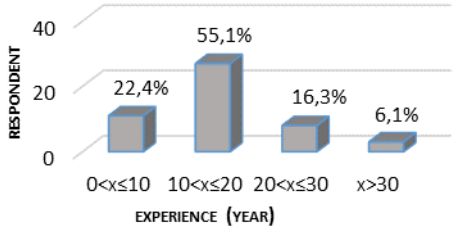

Fig 5: Respondents' Identity Based on the Duration of Work Experience

B. Respondent Preferences

The Wilcoxon test calculation of 127 questions in this research was exemplified at the criteria level for the (Question 1) pairwise comparison data between technical and non-technical factors. The respondent's selected values in sequence from the 49th sample data after being converted into ordinal scale are -4,-2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 3, 3, 3, 4, 4, 4, 4, 4, 4, 4, 4,

6, 6, 6, 6, 6, 6, 7, 7, 8. The median value of sequence is 2. The T value taken is from the T-value of 364. The value of the standardized test statistic (z) is a function of the T value, the average value (μT), and the standard deviation value (σT) [7] [8], as follows:

$$Z = \frac{T-\mu_T}{\sigma_T} = \frac{364-410}{72.121} = -0{,}638$$

$$\mu_T = \frac{n(n+1)}{4} = \frac{40\times(40+1)}{4} = 410$$

$$\sigma_T = \sqrt{\frac{2n(n+1)(2n+1)-\Sigma {t_j}^3-t_j}{48}}$$

$$= 72{,}122$$

The assessment of significance θ based on the value of z = -0.638 obtained P-value = 0.524, as P-value> α (0,05) then Ho is accepted (M = 2). The median value in the AHP scale format is 3. The value of 3 (three) as the combined preference value explains that the level of importance of the technical factor is slightly more important than the non-technical factor.

The examples of combined preference values of pairwise comparison in this research are shown in Table 2.

The Wilcoxon test for pairwise comparison subsequently uses SPSS software. The significance assessment for questions number 1, 2, 3, and 4 out of the respondent's answers are shown in Fig. 6.

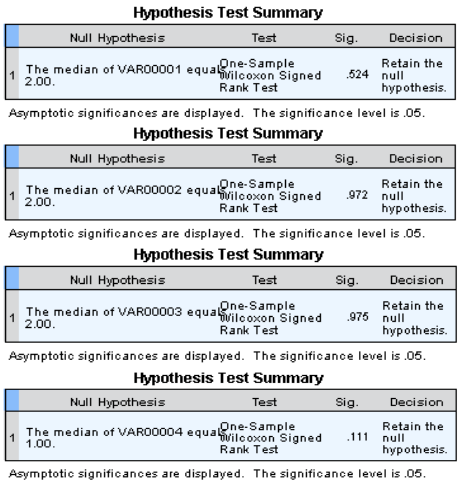

Fig 6: Example of Output of Respondents' Answers

C. *Respondent Preferences*

The calculation results to level 3 paired matrix of non-technical sub-criteria factors, from question number 2 to number 4, are arranged as shown in Table 3.

CI = 0,04
RI = 0,58
CR = 4,62% < 10% (accepted)

The CR value of 4.62% <10% indicates the calculation results of the consistency ratio of questions 2 to 4 can be accepted. The normalized weighting values for all attributes can be seen in Table 4.

TABLE II
Preference Value of Combined Pairwise Comparison

No	Questions		Median		P-value	AHP Value
	From	Towards	Initial Hypothesis	Accepted Hypothesis		
1	Technical	Non-technical	2	2	0,524	3
2	Development Plan Meeting	Public Proposal	2	2	0,972	3
3	Development Plan Meeting	Policy	2	2	0,975	3
4	Public Proposal	Policy	1	1	0,111	2

TABLE III
Level 3 Matrix Pair Matrix of Non-Technical Sub-criteria (3x3)

Criteria	Development Plan Meeting	Public Proposal	Policy	Mg	Value	Eigen Value
Development Plan Meeting	1	3	3	2.08	0.59	1.81
Public Proposal	1/3	1	2	0.87	0.25	0.76
Policy	1/3	1/2	1	0.55	0.16	0.48
Sample Measurement	3			3.50	1.00	3.05

TABLE IV
Attribute Normalization

Level 2		Level 3		Level 4		Level 5	
Attribute	**Weight**	**Attribute**	**Normalization**	**Attribute**	**Normalization**	**Attribute**	**Normalization**
Technical	75%	Maintenance	37,5%	LHR	6,28%	LHR≤2.000	0,28%
						LHR 2.000-19.500	0,45%
						LHR 19.500-27.100	0,73%
						LHR 27.100-72.900	0,97%
						LHR 72.900-109.400	1,50%
						LHR 109.400-145.900	2,35%
				Road Damage	12,81%	Severe Damage	8,63%
						Moderate Damage	2,89%
						Mild Damage	1,29%
				Road Networks	3,96%	Primary	2,64%
						Secondary	1,32%
				Land Use	3,52%	Preservation Zone	0,19%
						Trade Zone	0,75%
						Industrial Zone	0,51%
						Office Zone	0,58%
						Residence Zone	0,80%
						Productive Area	0,54%
						Non-productive Area	0,16%
				Road Function	7,05%	Collector	2,91%
						Local	2,31%
						Environment	1,83%
				Road Class	3,88%	Class I	1,72%
						Class II	1,50%
						Class III	0,66%
		Improvement	37,5%	LHR	5,78%	LHR≤2.000	0,23%
						LHR 2.000-19.500	0,39%
						LHR 19.500-27.100	0,61%
						LHR 27.100-72.900	0,93%
						LHR 72.900-109.400	1,41%
						LHR 109.400-145.900	2,21%
				Road Damage	12,03%	Severe Damage	8,53%
						Moderate Damage	2,15%
						Mild Damage	1,35%
				Road Networks	5,40%	Primary	4,05%
						Secondary	1,35%
				Land Use	3,40%	Preservation Zone	0,21%
						Trade Zone	0,73%
						Industrial Zone	0,66%
						Office Zone	0,60%
						Residence Zone	0,64%
						Productive Area	0,42%
						Non-productive Area	0,14%
				Road Function	6,07%	Collector	3,20%
						Local	2,02%
						Environment	0,85%
				Road Class	4,81%	Class I	2,86%
						Class II	1,20%
						Class III	0,76%
Non-technical	25,00%	Development Plan Meeting	14,84%				
		Public Proposal	6,23%				
		Policy	3,93%				

D. Description of AHP Weighting Results

Assessment of the importance of the technical aspects demonstrates that the road damage level has a greater percentage than other aspects. The distribution of the percentage of Level 4 attributes is shown in Fig. 7.

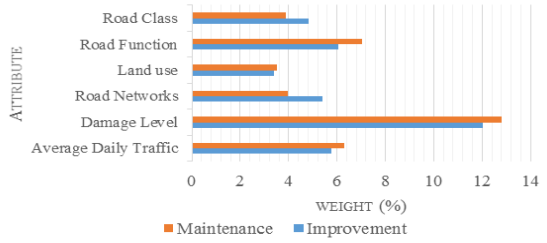

Fig 7: Level 4 Attribute Weighting

Weighting results using the AHP method shown in Table 4, consisting of technical (75.00%), and non-technical criteria (25%).

E. AHP Weighting Application on Road Management Priorities

The weight calculation results of maintenance work management can be seen in Table 5. The weight calculation results of the improving work management can be seen in Table 6.

The comparison results of the priority rank for road management conducted by the Office for Public Works and Spatial Planning of Banjarmasin using the AHP method based on technical and non-technical maintenance criteria can be seen in Table 7, while improvements can be seen in Table 8.

TABLE V
AHP Weighting Result for Maintenance

Assessment Item	Weight									
	Bumi Pertiwi II Road	Bumi Putera Road	Pinang Permai Residence Road	Hidayatullah Road	Wildan Sari III Road	POLRI Residence Road	STIE Indonesia Residence Road	Cendana Road	Harmoni II Road	Kayu Tangi 2 line 2 Road
Development Plan Meeting	14,84	14,84	14,84	-	14,84	-	-	-	-	-
Public Proposal	-		6,23	6,23	-	6,23	-	-	-	-
Policy	-	-	-	3,93	-	3,93	3,93	3,93	3,93	3,93
LHR≤2.000	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28
Mild Damage	0,09	0,52	0,62	0,38	0,24	0,58	0,18	0,14	0,16	0,07
Secondary	1,32	1,32	1,32	1,32	1,32	1,32	1,32	1,32	1,32	1,32
Residence Zone	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80
Environment	1,83	1,83	1,83	1,83	1,83	1,83	1,83	1,83	1,83	1,83
Class III	0,66	0,66	0,66	0,66	0,66	0,66	0,66	0,66	0,66	0,66
Total	19,81	20,24	26,57	15,42	19,96	15,61	8,99	8,94	8,96	8,87

TABLE VI
AHP Weighting Result for Improvement

Assessment Item	Weight									
	Banjar Utara Sector Residence Road	Handil Palung Road	Major AMD Alley	Manunggal 68 Road	Tirta Dharma PDAM Road	Melati Indah Road	Dasamaya 2 Residence Road	Barito Hilir Road	Kemiri Road	Cempaka Raya Road
Development Plan Meeting	-	14,84	14,84	-	-	-	-	-	-	-
Public Proposal	6,23	6,23	-	6,23	6,23	6,23	6,23	6,23	6,23	-
Policy	-	-	-	-	3,93	3,93	-	-	-	3,93
LHR≤2.000	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23
Severe Damage	5,26	8,53	1,84	5,18	-	-	5,95	2,18	2,52	-
Mild Damage	0,52	-	1,06	0,53	0,39	0,28	0,41	0,05	0,16	0,18
Secondary	1,35	1,35	1,35	1,35	1,35	1,35	1,35	1,35	1,35	1,35
Industrial Zone	-	-	-	-	-	-	-	0,66	-	-
Residence Zone	0,64	0,64	0,64	0,64	0,64	0,64	0,64	-	0,64	0,64
Local	-	-	-	2,02	2,02	2,02	-	2,02	-	2,02
Environment	0,85	0,85	0,85	-	-	-	0,85	-	0,85	-
Class III	0,76	0,76	0,76	0,76	0,76	0,76	0,76	0,76	0,76	0,76
Total	15,84	33,42	21,57	16,94	15,54	15,44	16,42	13,48	12,73	9,10

TABLE VII
Comparison of Priority Rank for Road Maintenance Management

No.	Office For Public Works and Spatial Planning of Banjarmasin	AHP Method
	Finished:	
1	Bumi Pertiwi II Road	Pinang Permai Residence Road
2	Bumi Putera Road	Bumi Putera Road
3	Pinang Permai Residence Road	Wildan Sari III Road
4	Hidayatullah Road	Bumi Pertiwi II Road
5	Wildan Sari III Road	POLRI Residence Road
6	POLRI Residence Road	Hidayatullah Road
7	STIE Indonesia Residence Road	STIE Indonesia Residence Road
	Unfinished:	
1	Cendana Road	Harmoni II Road
2	Harmoni II Road	Cendana Road
3	Kayutangi 2 Jalur 2 Road	Kayutangi 2 Jalur 2 Road

TABLE VIII
Comparison of Priority Rank for Road Improvement Management

No.	Office For Public Works and Spatial Planning of Banjarmasin	AHP Method
	Finished:	
1	Sektor Banjar Utara Residence Road	Handil Palung Road
2	Handil Palung Road	Major AMD Alley
3	Major AMD Alley	Manunggal 68 Road
4	Manunggal 68 Road	Dasamaya 2 Residence Road
5	Tirta Dharma PDAM Road	Sektor Banjar Utara Residence Road
6	Melati Indah Road	Tirta Dharma PDAM Road
7	Dasamaya 2 Residence Road	Melati Indah Road
	Unfinished:	
1	Barito Hilir Road	Barito Hilir Road
2	Kemiri Road	Kemiri Road
3	Cempaka Raya Road	Cempaka Raya Road

F. Discussion

From the results of the AHP weighting application, the used section assessment shows that the priority inclines towards the non-technical aspects, rather than the infrastructure itself. Thereby, the section assessment inclines more towards the user, the stakeholder (the person of interest), namely the person who sees the situation and feels firsthand what he goes through or passes, and perceives that the road he chooses has more important function. The result is: in determining the priority scale, non-technical aspects become the main indicator, supported by technical aspects as the secondary indicator. Based on these results, it can be determined that if the incoming section comes from Development Plan Meeting (non-technical), it is certain that the segment is included in the priority. In practice, after the determination of the non-technical aspects, the technical aspects trail behind with their indicator assessments, such as LHR, level of road damage, land use, road class, and road function. From the calculation results of the AHP method based on the attributes used in this research, non-technical aspects have tremendous influence, in addition to Development Plan Meeting, which absolutely determine the value of a section in road management priority. The visible weakness is that political policy has a highly subjective judgment, contributing to an increase in the percentage of an assessment. However, the advantage of the AHP method from the results of this research lies in the decision making, involving the stakeholders and the community who take part in determining the public policy.

V. CONCLUSIONS

The factors that influence the weighting in the AHP method on priority rank for road management in Banjarmasin in this research are technical factors (maintenance and improvement) and non-technical factors (Development Plan Meeting, public proposals, and policies). Technical factors have

3 (three) times the weight (75%) from that of the non-technical factors' (25%).

However, in overall, judging from the fulfilment of non-technical indicators, they apparently have a massive weight: the most important factor is shown by Development Plan Meeting with a weight of 14.48%. As for the technical aspects, both for maintenance and improvement, they are shown by severe damage indicator with an interest level of 8.63% in terms of maintenance, and 8.53% for improvement. The decision comparison result between the AHP method and the existing implementation shows that they produce a not-so-different decision, where the placement of the finished and unfinished section groups remain the same or unchanged. It demonstrates that the segment assessment design using AHP is applicable.

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