Decision Support System to Determine Priorities for Handling Road Repair in Banten Province Using Analytical Hierarchy Process Method

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Abstract—The Public Works and Spatial Planning Office of Banten Province is a government institution tasked with handling infrastructure such as roads, bridges, culverts, sidewalks and street lighting. In repairing roads and bridges it is necessary to make a priority plan to determine which roads and bridges need to be repaired. At present in determining priorities for road and bridge repairs, the Public Works Agency is getting information from the results of surveys and proposals from relevant agencies. From the results of surveys and agency proposals, information was obtained that many roads and bridges were damaged. Due to budget constraints from the government, the Public Works Agency must determine priorities regarding road conditions that must be improved first. The purpose of this study is to determine the priority of roads and bridges that must be repaired based on the criteria of the road that has suffered the most damage so it must be repaired immediately. The AHP method is used to find the best alternative from the many alternatives available about the survey information and related agency proposals regarding damaged roads. As a result, using the AHP method can determine priorities for road and bridge repair accurately.

Keywords: Decision Support System, priority, AHP

I. INTRODUCTION

Road conditions determine the comfort of road users, the convenience of road users is the Responsibility of the Office of Public Works and Spatial Planning in each region. Therefore if there is damage to infrastructure facilities such as damage that is on the Road then it has become the authority of the Workers' Office. The application of this method has been proven successfully in the problem of decisions relating to technical and economic fields, namely for: selection of supplier variants, selection of investment projects, and selection of certain types of equipment to be purchased through modernization projects, divisions of financial resources based on certain budgets, etc.[1]. In the good management of the planning, maintenance, and repair of road infrastructure there are still obstacles such as the number of roads that must be repaired, but the limited cost of the central government so that not all damaged roads can be handled. Based on the above problems, it is necessary to conduct

research to create a decision support system to determine the priority of road improvement in the Banten Province region. In this study the AHP method was chosen because the concept of this method is able to decompose complex problems into a hierarchical form, using weighting criteria, and reducing subjectivity. AHP method is able to give consideration in decision making to determine the priority of road improvement from existing road alternatives. The purpose of this study is to determine the priority scale of road improvement which is the authority of the Public Works and Spatial Planning Office (PUPR) in accordance with the Banten Provincial government budget. AHP method is used in data processing from the PUPR service. After processing the data using the AHP method, the Public Works Agency can determine which road has the most damage so that the road becomes a priority for immediate repairs by the PUPR service

II. LITERATURE REVIEW

A. Decision Support System

DSS is a computer-based system, built to solve various problems. Problem scenarios by analyzing the feasibility of each scenario in a short amount of time to provide an optimal solution close between them. DSS can also be applied to various problems and solutions that might integrate aspects of sustainable development or not [2]. Decision support systems (DSS) can be used to make up for lack of knowledge and to monitor manufacturing indicators and make suggestions for improvements in production from a sustainable perspective [3]. This is demonstrated in several literature reviews that consider a DSS system of sustainable manufacturing [4]. DSS combining normative strategies increases accuracy and reduces the amount of cognitive effort needed to assess each attribute and alternative and the time needed to make decisions [5].

B. Analytical Hierarchy Process (AHP) Method

AHP method is a systematic decision making method that includes qualitative and quantitative techniques [6]. The AHP

method is useful for obtaining an assessment based on different indicators or criteria. This simplifies the decision making process by grouping complex problems into a series of structured steps in which each element in the criteria hierarchy should be independent of the others. The AHP method is applied in many fields of scientific research [7]. Decision making about strategic questions is not easy but using AHP, managers can ascertain some mistakes that can occur during the decision making process [8]. In complex decision making systems where there are many variants of factors regarding quantity and quality aspects, the Multiple Criteria Decision Making (MCDM) method is used to support decision making processes. The simplest of them are: Weighted Sum Models (WSM) and Weighted Product Models (WPM). One method used to support the decision making process is the Analytic Hierarchy Process (AHP) method [9]. The hierarchical construction of decision elements is interconnected, with the following components: main objectives, criteria and alternative solutions realize the main objectives [10]. The hierarchy is presented in the form of a tree [11].

III. METHODOLOGY

A. Location Study

The location of the study was carried out on a road section under the authority of the Banten Provincial Government, can be seen in Figure 1.

Fig.1. Map of the Authority of the Banten Provincial Government

B. Data Collection

After conducting a location study, the next is input data. Data was obtained from the Public Works and Spatial Planning Office of Banten Province. Road data consists of the names of road sections, road names, road conditions, types of damage, traffic conditions and budget. At this stage the data received is in the form of Microsoft Excel.

C. Determine the Priority Scale for Road Improvement Using the AHP Method

AHP is a useful method in the decision making process based on mathematics and psychology [12]. The stages in the AHP method:
Step 1: Creating a hierarchical structure [13]. At this stage the hierarchical structure is organized into 3 levels, level 1 determines objectives, level 2 determines criteria and level 3 determines a series of alternatives
Step 2: Make a Criteria Matrix and determine Relative Weights. In this step, for specific applications, the decision maker makes a series of pairwise comparisons between

criteria according to the Semantic scale of Saaty [14]. The resulting matrix aims to ensure the consistency of the score given, the decision maker verifies whether the consistency ratio (CR) is less than 10%. Higher CR values reveal a lack of transitivity in many matrices that correspond to contradictory assessments; hence, this situation forces the revision of the assigned score [15]
Step 3: looking for weights using the AHP method. The criteria used are road conditions, types of damage, traffic and budget. There are 10 roads that will be used as alternatives. The next step that must be done is to determine the intensity value as a comparison value based on existing criteria. The intensity value is made based on the characteristics of the data and will still refer to the standard nine-point scale that exists in the AHP method [16].

TABLE 1. THE SCALE OF FUNDAMENTAL ABSOLUTE NUMBERS [17]

Level	Remark
1	Both elements have the same effect
3	Experience and judgment favor one element more than the partner
5	Experience and decisions show preference for one activity more than another
7	Experience and decisions show a strong fondness for an activity more than others
9	One element is preferable to his partner, at the highest level of confidence
2,4,6,8	When compromise is needed

Step 4: making a comparison matrix between criteria and criteria, and criteria with alternatives that refer to the previously obtained intensity values. After making the comparison matrix, the next step is to calculate the eigenvalue and calculate the eigenvector or priority value as a weight [18]. To get the eigenvalues the comparison matrix must first be normalized. The researcher also tried not to use normalization, but if the comparison matrix was not normalized, the consistency of the ratio obtained> 10% then the data was not suitable for use because it was inconsistent. After that the weight will be obtained and then the calculated value is the consistency index (CI) as a test of consistency matrix [19]. The exact matrix is consistent if the value of CI = 0, if the value of CI> 0 then a consistency ratio (CR) test must be performed to calculate the limit of the consistency of the matrix. The matrix is still consistent if the value of CR <10%. If CR> 10%, the matrix is not consistent. To calculate CI

CI = (λmax –n) / n. After determination of λ, the consistency index (CI) and CR are calculated [20]:

$$CI = \frac{\lambda max - n}{n - 1}$$

IV. RESULT

A. Criteria Calculation

To get priority scale of road repair and handling in Banten Province can be calculated using the AHP method. The following calculations:

1) Make a Hierarchical Structure to determine the objectives, criteria and alternatives for road repair and handling in Banten Province.
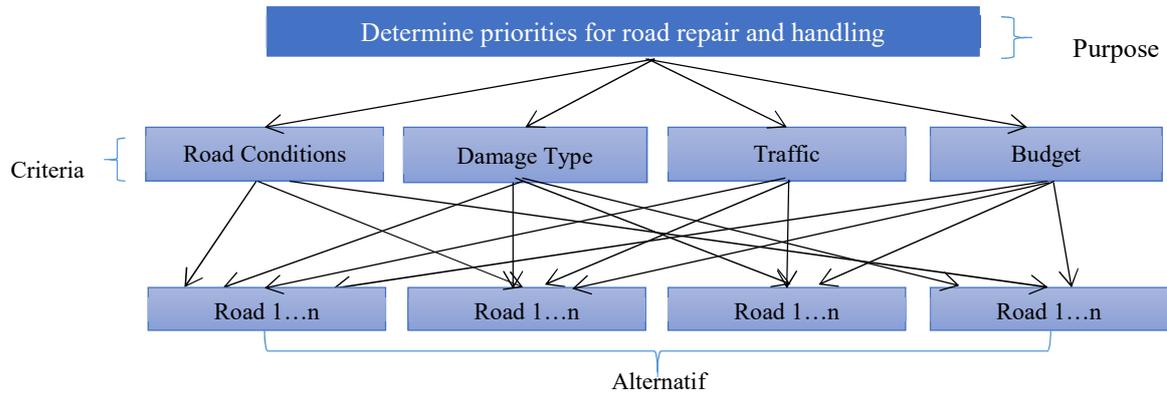

Fig.2. Hierarchy structure for road repair and handling

2) Create and calculate a Pairwise Comparison Matrix for each criterion and a realistic weight

TABLE 2. PAIRWISE COMPARISON MATRIX CRITERIA

CRITERIA	ROAD CONDITION	TYPES OF DAMAGE	TRAFFIC CONDITIONS	BUDGET
ROAD CONDITION	1	1/3	1/4	2
TYPE OF DEMAGE	3	1	1/3	5
TRAFFIC	4	3	1	5
BUDGET	1/2	1/5	1/5	1

3) Normalizing the values in the matrix to produce an eigen vector value, can be seen as follows:

TABLE 3. NORMALIZATION RESULT CRITERIA CRITERIA

CRITERIA	ROAD CONDITION	TYPES OF DAMAGE	TRAFFIC CONDITIONS	BUDGET	TOTAL	EV
ROAD CONDITION	0,12	0,07	0,25	0,14	0,58	0,15
TYPE OF DEMAGE	0,35	0,22	0,63	0,19	1,39	0,35
TRAFFIC	0,06	0,04	0,13	0,11	0,34	0,09
BUDGET	0,47	0,66	0,63	0,56	2,32	0,58

4) To get the maximum Eigen (λmax), i.e. by multiplying the Priority Vector with the Eigen Vector that has been obtained previously. And the results can be seen as follows

TABLE 4. THE CALCULATION RESULTS CI AND CR

Matrik Pairwise Comparation				EV		Total		λmaks	4,223
1,00	0,33	2,00	0,14	0,15		0,51		CI	0,074
3,00	1,00	5,00	0,33	0,35	=	1,40		CR	0,083
0,50	0,20	1,00	0,20	X 0,09		0,34		Hasil	Konsisten
7,00	3,00	5,00	1,00	0,58		3,06			

So, from the matrix above can be determined Consistency Ratio (CR) is 0.083. CR <0.1, then the matrix is declared consistent.

TABLE 5. ALTERNATIVE CALCULATION RESULTS

	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10
R 1	1,00	0,50	3,00	4,00	0,33	2,00	0,50	0,33	2,00	4,00
R 2	2,00	1,00	4,00	6,00	0,17	3,00	0,50	2,00	0,50	0,50
R 3	0,33	0,25	1,00	0,50	3,00	0,33	4,00	5,00	0,17	3,00
R 4	0,25	0,17	2,00	1,00	3,00	2,00	2,00	3,00	4,00	2,00
R 5	3,00	6,00	0,33	0,33	1,00	6,00	5,00	5,00	4,00	7,00
R 6	0,50	0,33	3,00	0,50	0,17	1,00	4,00	3,00	2,00	2,00
R 7	2,00	2,00	0,25	0,50	0,20	0,25	1,00	5,00	5,00	7,00
R 8	3,00	0,50	0,20	0,33	0,20	0,33	0,20	1,00	3,00	2,00
R 9	0,50	2,00	6,00	0,25	0,25	0,50	0,20	0,33	1,00	4,00
R 10	0,25	2,00	0,33	0,50	0,14	0,50	0,14	0,50	0,25	1,00

The final result is determining the scale of road repair and handling in Banten Province. The following figure is the result of calculating the priority scale of road repair and handling that has been obtained from the calculation of the Decision Support System using the AHP (Analitycal Hierarchy Process) method.

TABLE 6. SUPPORT SYSTEM USING THE AHP

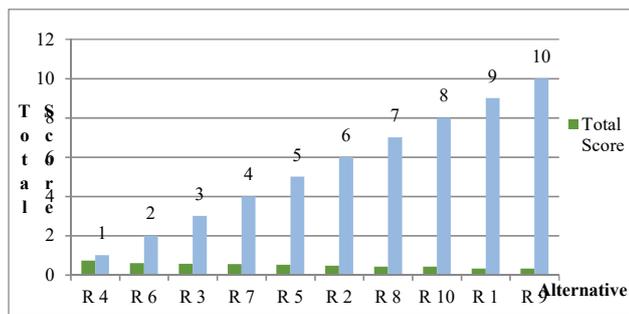| Roads	Street Name	Total Score	RANK
R 4	Lopang - Banten Lama	0,724	1
R 6	Jl. Trip Jamaksari	0,604	2
R 3	Ciruas - Petir - Wr.Gunung	0,564	3
R 7	Jl. Ayip Usman	0,554	4
R 5	Palima - Pasang Teneng	0,513	5
R 2	Jl. A. Yani (Serang)	0,471	6
R 8	Jl. Akses Pelabuhan Karang Hantu	0,425	7
R 10	Pakupatan - Palima	0,414	8
R 1	Jl. KH. Syam'un	0,332	9
R 9	Jl. Veteran	0,328	10

Fig.3. Final Results determining the priority scale for road repair and handling

Based on the criteria of road conditions, types of damage, traffic conditions and budget, the priority scale of road repair and handling in Banten Province was obtained. The main priority road for immediate repairs is R 4, the Old Lopang-Banten road with the highest value of 0.724

V. CONCLUSION

Roads as national transportation are built because they are the main supporting factors in the social, cultural and environmental fields. Road conditions determine the comfort of road users, the convenience of road users is the responsibility of PUPR Service in each region. Therefore if there is damage to infrastructure facilities such as damage that is on the Road then it has become the authority of the Workers' Office. In the good management of planning, maintenance, and repair of road infrastructure there are still obstacles such as the number of roads that must be repaired and the most important is the limited cost from the central government so that not all damaged roads can be handled. Based on the above problems, it is necessary to conduct research to create a decision support system in determining the priority of road improvement in the area of Banten Province. This research uses Analytical Hierarchy Process (AHP) method, a method that is able to provide problem solving in decision making to determine the priority of road management carried out by the Government of Banten Province.

Based on the results of calculations using the AHP method, 4 predetermined criteria are road condition criteria, damage type, traffic and budget, the priority scale of road repair and handling in Banten Province is obtained. Furthermore, the top priority for immediate road repair and handling is Section 4, Lopang-Banten road with the calculation result of 0.724

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