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Study of Road Maintenance Program Priority, Using the Analytical Network Process

M Surbakti¹,²* and K C Harefa³

¹Civil Engineering Department, University of Sumatera Utara, Jl. dr. Mansur Kampus USU Medan 20155.
²Sustainable Transportation Research Center, Faculty of Engineering University of Sumatera Utara, Jl. Almamater Kampus USU Medan 20155
³Civil Engineering Post Graduate Program, Faculty of Engineering University of Sumatera Utara, Jl. Almamater Kampus USU Medan 20155

*medis@usu.ac.id

Abstract. On the implementation of the maintenance roads works in Nias, there has been no standardized system, in terms of work priority order. The purpose of this study was to determine the priority of strategic road order, with Analytical Network Process (ANP), which is based on technical criteria as the basis for determining the priority policy for development or maintenance of roads in Nias. As the results, several criteria based on stake holder judgment, which can be used as the basis for maintenance priority program of road, respectively are: accessibility 30.87%; regional connectivity 25.33%; movement needs 17.90%, regional strategic development purposes 13.49%, and road condition 12.42%.

1. Introduction
Based on Nias Regency Regulation No. 1/2014, on Nias Regency Spatial Planning (RTRW) Year 2014-2034, Nias district government has established transportation system development plan [1]. One of the regulation is the development of the strategic road network [2].

Nias Regency has limited funds for the maintenance of their road network. It can be seen from the road network that tends not get sufficient maintenance funds. The phenomenon that occurs is, there are roads that very rarely have maintenance program, while in other places there is a road that almost every year to get the maintenance fund. This is due to the limited funds they have, and it cannot be separated from road management policies that assess the needs of road maintenance, which is done almost subjectively.

Based on the background as described above, several problems that occurs are:
- Which factors that need to consider in determining the maintenance priority program for strategic road link in Nias district.
- Which factors that very influential in determining the maintenance, for strategic road in Nias district.
- How the order of maintenance priority?

The purpose of this study was to determine the order of priority for strategic road network maintenance program, with Analytical Network Process (ANP) tools, based on technical criteria as the basis for determining policy on the maintenance of roads in Nias.
The results of the research can be used to help Nias regency government in setting priorities and optimize the allocation of funds in the management of strategic roads as well as a reference for future research priorities related to road maintenance.

In determining priorities, required several criteria that form the basis for assigning weights to the existing selection. Some previous researchers use different criteria in determining the priority of improving road according to local conditions examined. Afriansah et al [3], in the "Prioritizing the development of the road network as supporting strategic importance on the island of Sumbawa". The analysis was performed by using AHP with the criteria of economic, social, accessibility, road conditions, cost and suitability procedures. Totaling 16 (sixteen) that experts and stakeholders as respondent. Nafiah [4] in the "Study Prioritizing Handling Roads with Analytical Hierarchy Process Method" The results of the questionnaire in 5 respondents from the Department of Roads and Bridges in North Sumatra Province indicate that the handling fee is the most considered criteria that is equal to 61.33%, while the criteria for the condition of the road amounted to 22.66% and traffic volume criterion of 16.01%. Analysis with AHP method that generate a sequence of 75 roads are a priority then compared to the priority that has been done by the government.

One method research approach with a qualitative - quantitative, and involves a lot of criteria are Analytic Network Process (ANP). This method is one of the methods Multi-Criteria Decision Making (MCDM) developed by Thomas L. Saaty [6]. ANP is the solution to overcome the limitations in the methods of its predecessor, the AHP (analytic hierarchy process) or a generalization of AHP, Goepel K.D., [7]. In addition to the AHP, ANP become more common methodology and more easily applied to such diverse qualitative study of decision-making, priorities, evaluation, mapping, strategy, resource allocation and so forth, Firstadi, [8].

2. Method
2.1 Types of research
Research on this study are based on questionnaire data. The information collected through respondents using questionnaires form.

Figure 1. Hierarchy Structural of Purpose, Sub criteria and Alternative with ANP Method
2.2 Research areas

Research areas include nine (9) Nias district strategic roads that are part of the 27 (twenty-seven) strategic road segments that have been assigned based on the RTRW Nias Regency Year 2014-2034.

2.3 Research variable

The variables used in this study consisted of the criteria on the basis of considerations maintenance priority for strategic roads in Nias through the interview to the respondent. Hierarchy of ANP structural on this study that shown criteria (I), sub criteria (II) and alternative (III) describes at Figure 1.

To maintain consistency and ease in filling the questionnaire conducted by the respondent, the process of data collection is done by using a paired comparison simplified, can be seen in Table 1 below.

| Criteria | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|----------|---|---|---|---|---|---|---|---|---|
| A        |   | X |   |   |   |   |   |   |   |
| B        |   |   | X |   |   |   |   |   |   |
| C        |   |   |   | X |   |   |   |   |   |
| D        |   |   |   |   | X |   |   |   |   |
| E        |   |   |   |   |   | X |   |   |   |

Variables above is the result of the validation of 3 (three) experts / respondents who are experts in their field and know the prioritization of maintenance roads in Nias. Validation is done by oral and written interviews.

![Figure 2](image.png)

Figure 2. Model of network prioritization of strategic roads Nias
2.4 Modelling Framework ANP
In this research, the design model of ANP structure consisting of three clusters, namely; (1) cluster "of interest" determination of priority roads, (2) cluster "criteria" that consists of five elements, (3) cluster "alternative" consisting of 9 roads. Furthermore, the justification for the interconnection between clusters and elements, for example: cluster "alternative" influenced or has associated with clusters of "criteria" and vice versa, cluster "criteria" influenced or has associated with elements that are inside. Justification is an important linkage to form the basis of making the matrix.

3. Results and Discussions

3.1. Network Structural of Priority for road maintenance program at Nias Regency
The result for variable validation to three respondents who in charge and have a better understand and to prioritization of road maintenance program at Nias regency, are describes on ANP structural form that shown at Super Decision Software in Figure 3. This network is a conceptual framework that describes the overall problems in related research in determining the maintenance priority program of roads in Nias

![ANP Network Structure at Super Decision](image)

Figure 3. ANP Network Structure at Super Decision

3.2. Pairwise Comparison (Pairwise Comparison)
In this phase, the data obtained through in-depth interviews with seven (7) respondents. Furthermore, after the results of information collected and arranged in the form of questionnaires, comparisons then proceed with filling the questionnaire to the seven (7) of the respondents authorized in terms of the prioritization of road maintenance.

Through the pairwise comparison results in a cluster criterion we can know Eigen vector magnitude at each of the criteria and consistency in cluster "Criteria" itself,
3.3. **Analysis of Each - Each respondent**

The results of questionnaires of all respondents can be seen in Table 2 below.

### Table 2. Average Value of Priority Criteria

| Rank | Criteria               | R1   | R2   | R3   | R4   | R5   | R6   | R7   | Average |
|------|------------------------|------|------|------|------|------|------|------|---------|
| 1    | Accessibility          | 0.1688 | 0.2220 | 0.1860 | 0.2217 | 0.1827 | 0.2219 | 0.2374 | 0.2058 |
| 2    | Connectivity          | 0.2237 | 0.1894 | 0.1255 | 0.1817 | 0.1596 | 0.1415 | 0.1605 | 0.1688 |
| 3    | Accommodate Travel Need | 0.1143 | 0.1060 | 0.1305 | 0.0794 | 0.1875 | 0.0840 | 0.1336 | 0.1193 |
| 4    | Strategic Area Development | 0.1131 | 0.0961 | 0.0824 | 0.0713 | 0.0857 | 0.0877 | 0.0931 | 0.0899 |
| 5    | Road Condition        | 0.0468 | 0.0533 | 0.1422 | 0.1126 | 0.0511 | 0.1316 | 0.0420 | 0.0828 |

![Figure 4](image-url). Graph Priority Value Each Respondents Against Criteria

3.4. **Priority Scale Analysis Based on Overall Criteria**

The end of the calculation of pairwise comparison of two clusters related to the prioritization of maintenance strategic roads in Nias can be seen in Table 3 below.
### Table 3: Priority Order Based Connectivity Criteria Region, Travel Needs Accommodation, Accessibility, Development Strategic Area and Road Condition

| Rank | No Segment | District            | Road Section                                      | Connectivity | Accommodate Travel Needs | Accessibility | Development of Strategic Area | Road Condition | Based on all Criteria |
|------|------------|---------------------|--------------------------------------------------|--------------|---------------------------|--------------|-------------------------------|----------------|----------------------|
| 1    | 901.001    | Gido-Ma’u           | Hiliweto-Lasara siwalubanua                      | 0.2747       | 0.1349                    | 0.2759       | 0.0911                        | 0.2677         | 0.2225               |
| 2    | 910.001    | Sogaeadu-Somolo molo| Sogaeadu-Somolo-molo                             | 0.2005       | 0.0964                    | 0.1368       | 0.0695                        | 0.1223         | 0.1397               |
| 3    | 902.003    | Idanogawo-Ulugawo   | Tetehosi-Holi                                    | 0.1303       | 0.1146                    | 0.1438       | 0.0638                        | 0.1561         | 0.1255               |
| 4    | 902.001    | Idanogawo           | Tetehosi-Bozihona                                | 0.0890       | 0.1686                    | 0.1030       | 0.2238                        | 0.0600         | 0.1216               |
| 5    | 901.008    | Gido-Sogaeadu       | Somi-Laira                                       | 0.0883       | 0.0456                    | 0.1085       | 0.2051                        | 0.1969         | 0.1160               |
| 6    | 904.002    | Bawolato            | Huno-Hou                                         | 0.1027       | 0.1335                    | 0.0870       | 0.0488                        | 0.0539         | 0.0924               |
| 7    | 904.001    | Bawolato            | Sindrondro-Tagaule                               | 0.0503       | 0.0275                    | 0.0581       | 0.1955                        | 0.0810         | 0.0686               |
| 8    | 908.001    | Hiliserangkai-Botomuzoi | Dahadano botombawo-Ononamolo talafu | 0.0448       | 0.1163                    | 0.0379       | 0.0503                        | 0.0395         | 0.0576               |
| 9    | 903.001    | Hiliduho            | Hilina’a-Lasara                                  | 0.0321       | 0.1532                    | 0.0224       | 0.0522                        | 0.0226         | 0.0560               |
4. Conclusions
1. Based on the interview to the three respondents who are experts, as well as perform validation associated with the selected criteria to determine the maintenance priority of roads in Nias, this study obtained several criteria i.e.: accessibility, connectivity territory, Accommodation Needs Travel, Road Condition and Development Strategic Area.
2. The results of the questionnaire to 7 (seven) respondent and make an analysis using Analytic Network Process (ANP) with Super Decision software, shows that five of these criteria were used in the study of the determination of priority maintenance roads program in Nias respectively is; accessibility which is a criteria that influence the value of 0.3087, or 30.87%, then the connectivity territory of 0.2533, or 25.33%, and followed the accommodation travel needs 0.1790 or 17.90%, the development of strategic areas 0.1349 or 13.49% and road conditions that influence for 0.1242 or 12.42%.
3. In accordance with network modeling using ANP method with 5 criteria, generated an order of nine road priority maintenance program.

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