Identified solution management in the landfill with analytic network process

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Abstract. The solution to solve these challenges is the waste management. The waste management is needed to solve starting from upstream to downstream. The waste management in downstream is in the landfill. The management Landfill not only manages solid waste but also waste water treatment. One form of waste water treatments in a landfill is the leachate treatment. The leachate treatment is a priority for management in landfill because it can reduce water, soil, air pollution in the landfill and the surrounding environment. In order to determine the best option among several alternatives to manage the leachate treatment, this research used Analytic Network Process (ANP) with three levels (actors, criteria, and alternatives). Secondary and primary data collection was carried out from April until June 2019 in Indonesia. Data were collected through a survey using questionnaire instrument. Participants of questionnaire amount of 20 people. The participants from lecturers, government, and society. The finding of this research showed that the leachate treatment using coagulation-flocculation was easier to be used in Indonesia.

Keywords: Analytic Network Process, coagulation, leachate

1. Introduction

1.1. Background

The population growth has the impact to increase the production of solid waste. Mokhtarani [1] stated that the world’s municipal solid waste (MSW) production rate was increased per year. The landfill is a storage waste around the world [2]. This method is an easy operation [3]. It products to the gaseous emissions and liquid leachates [2]. Open dumping landfills, managed landfills and sanitary landfills are classified landfill [4]. Open dumping landfills are mostly found in Indonesia. It is usually produces leachate from decomposed organic and inorganic compounds [5]. The leachates follow rainwater percolation. They contain a large of mineral, microbiological, and organic materials that can cause
dangerous environmental pollutions of soils, air, and groundwaters [2]. The leachate treatment has become important to save the environment.

The decision-making technique is used in determining the leachate treatment. The decision-making technique can use the Analytical Hierarchy Process (AHP) method. It is used to simplify problem and strategic alternatives into its organize them in a hierarchy [6]. From these advantages, it turns out there are weaknesses of AHP, some of which are the arrangement of AHP bottom up, cannot provide feedback, and ranking can change. To meet these weaknesses, Analytic Network Process (ANP) is created. ANP is chosen because of the complex problems in selecting leachate processing in TPA, namely the existence of several actors, interrelated elements of the criteria and the existence of interdependencies and to maintain consistency in the assessment of criteria and alternative decisions. The another method from AHP is Analytical Network Process (ANP) method. We can see the interaction and feedback of each of the elements in the cluster with ANP [6,7].

1.2. Objective
The objective of the research to determine the best option among several alternatives to manage the leachate treatment.

2. Methodology
The research use primary and secondary data. primary and secondary data collection was carried out from April until June 2019 in Indonesia. Data were collected through a survey using questionnaire instrument. The respondent of questionnaire are from lecturer, government, and society. It consists of 20 people. The respondents are those who know about the solid waste and the leachate treatment. The results of the questionnaire were processed using software.

ANP is a method that can be used to describe relationships between elements [8]. According to Rusydiana et al. [9], That is able to explain the model of dependence factors and their feedback systematically. In general, steps that should be taken in using ANP are:

1. Defining the goals, actors, criteria, and alternatitves.
2. Determining the value of each element.

Saaty [10] suggested the technical analysis of ANP by using pairwise comparison on alternatives and project criteria. The research are levels of goals, actors, criteria, and alternatives, each of which has an element. Sadeghi [11] argues that the advantages of ANP are the ability to solve problems where alternatives and criteria that have these interactions cannot be displayed in a hierarchy. Interaction built from this research is Intarchy, namely hierarchy with a feedback cycle between three middle levels in sequence (table 1)

| Level       | Criteria                               |
|-------------|----------------------------------------|
| Goal        | The leachate treatment                 |
| Actors      | Lectures, Government, Society          |
| Criteria    | Efficiency, Cost, Technic              |
| Alternatives| Coagulation-Floccolation, Sludge Activated, Anaerobik |

3. Results and Discussion
Figure 1 is a form of hierarchical analysis using ANP method through super decision software. Actors who play a role in leachate processing are lecturers, government, and society. The role of the lecturer is to provide recommendations on the model and leachate processing techniques used. The government is in charge of providing assistance and assistance in both services and materials, while the community plays a role in management and operations.
Based on the cluster design and nodes in the analysis using ANP mentioned above, the relationship between nodes and clusters in analyzing the model in ANP method can be seen in figure 2. This table shows the analysis of the supermatrix model from the ANP method consisting of alternative, cluster and connectedness between nodes. That figure shows consistency from elements. Cost element is the most important element from this study.

The use of Super Decisions software can only use 1 expert opinion so that in the case there are 20 experts, it is necessary to combine the opinion process. The opinions of expert 1 until 20 are combined with the geometric average method. The results of this opinion merger are then processed using the Super Decisions software. Based on the results of comparisons on 12 matrices obtained inconsistency values < 0.00532, this indicates that expert 1 until 20 have been consistent in answering pairwise comparisons between these elements. This measurement of consistency is needed to find out the consistency of the answers that will give effect to the validity of the results. The assessment matrix for both clusters and nodes is an input in determining the weight of both criteria and alternatives. Weight calculation consists of a series of processes which include:
1) Calculation of eigenvalues in the cluster matrix and matrix nodes.
2) Preparation of a non-weighted super matrix with input from the eigenvalue on the matrix node.
3) Normalization of super matrices as multiplication of a weighted matrix with super matrix.
4) Super limit matrix calculation.

The ANP supermatric results from "selection of leachate treatment in the landfill to be used" are as follows figure 3. The most important element of government actors is cost, while for lectures and society is efficiency.

![Figure 3. Super Matrix Normalization.](image)

From the results of the pairing matrix value weighting process, the results of the comparison of priority weights are obtained using the ANP method (figure 4). Figure 4 shows that the highest from criteria is efficiency and the highest value from alternatives is coagulation-floculation. The value of efficiency is 0.52694 and the value of coagulation-floculation is 0.61735.

![Figure 4. Priority Recapitulation.](image)
After all input values have been carried out and the calculation is done using a Super Decision, the results or full report from the ranking type that will be used for the selection of leachate processing at landfill using the ANP method will be displayed in html or web form (figure 5). Figure 5 explains the alternatives, network types, and clusters used in this study. Figure 5 also shows the alternative ranking of this study. The first rank of this research is coagulation-flocculation.

**Main structure of toplevel network**

What follows a brief recap of this network.

If you would like to, you can return to the main menu.

| Alternative(s) in it:     | Coagulation-Flocculation | Sludge Activated | Anaerobic |
|---------------------------|--------------------------|------------------|-----------|
| Network Type              | Bottom level             |                  |           |
| Formula                   | Not applicable           |                  |           |

| Clusters/Nodes            | Government: description | lectures: description | Society: description |
|---------------------------|-------------------------|-----------------------|----------------------|
|                           | Alternatives: description | Anaerobic: description | Coagulation-Flocculation: description |
|                           | Criteria: description | Cost: description | Efficiency: description |
|                           | Techinc: description |                          |                      |
|                           | Goal: description | the leachate treatment: description |

**Figure 5.** Rekapitulasi report After Finish.

Based on the final report of the analysis using the ANP method, coagulation-flocculation is the first alternative choice in the selection of types to be used for leachate processing activities (figure 6).

**Figure 6.** Sensitivity analysis.

The results of synthesis from the selection of leachate processing to be used with the ANP method using software super decisions can be seen in figure 7. Taking into account that the cost aspect is a top priority in selecting leachate processing, coagulation-flocculation is the top priority chosen.
Figure 7. Synthesis with ANP.

The results of the study using the ANP method shows that coagulation-flocculation is the main processing alternative with normalization values of 0.6173375 (figure 8). the value is close to 1. So the result causes coagulation-flocculation to be ranked first. The alternative treatment chosen from this research is coagulation-flocculation.

Figure 8. Node ANP.

4. Conclusions and Recommendation
ANP method can be used to make decisions, one of which is to determine the alternative leachate processing. The results of this study were obtained by the actor who played the most role in this activity was the government with a value of 0.44343. The highest value on the criteria element is efficiency with value 0.52694. The highest alternative element is coagulation-flocculation with value 0.61735. This study, the best option among several alternatives to manage the leachate treatment is coagulation-flocculation.
5. References

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