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Application of the Analytic Hierarchy Process (AHP) Method in Supporting Go Green Policies for Environmental, Economic, Social and Technological Sustainability

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ABSTRACT

The Go Green policy aims to create environmental, social and economic sustainability through the better management of natural resources and technology. Decision-making in implementing the Go Green policy requires a method that can handle various interrelated criteria. One effective method is the Analytic Hierarchy Process (AHP), which allows the selection of policy alternatives by taking into account the main factors systematically and objectively. This research applies the AHP method to evaluate Go Green policy alternatives based on four main criteria: environmental, economic, social and technological sustainability. The analysis results show that the use of renewable energy is the best policy that can support the implementation of Go Green, with a score of 0.50.

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1. INTRODUCTION

Policy Go Green is an important step taken by many countries to reduce negative impacts on the environment and support sustainability [1]. Implementation of the Go Green policy requires careful evaluation of various factors that can affect its effectiveness, both in terms of economics, social, environment, and technology [2]. This policy involves steps to reduce the carbon footprint, introduce environmentally friendly technologies, and ensure sustainability in social and economic aspects [3][4]. Governments and organizations around the world are now increasingly interested in implementing this policy effectively. However, in practice, decision-making in Go Green policies involves many conflicting alternatives, which requires tools that can help identify the best alternative [5]. One method that can be used to support this decision-making is Analytic Hierarchy Process (AHP), which allows for decision analysis based on weights of interrelated criteria [6].

AHP can be used to break down complex problems into simpler components in the form of a hierarchical structure, where policy alternatives can be compared based on predetermined criteria [7]. AHP can be used to assess various policy alternatives by considering many related criteria, such as environmental, economic, social, and technological sustainability [8][9]. By using AHP, decisions taken can be more objective and accurate, by considering various relevant factors.

2. METHOD

2.1. Go Green Policy

The Go Green policy aims to create a balance between environmental sustainability, natural resource management, and the development of environmentally friendly technology [10]. As part of a sustainable development strategy, the Go Green policy integrates three main pillars: environment, economy, and social [11]. Sustainable management of natural resources, reduction of carbon emissions, and application of environmentally friendly technologies are the main steps that can be taken to achieve this goal [12]. Implementation of these policies requires in-depth analysis of various factors such as environmental impacts, social benefits, and economic impacts [13].

2.2. Analytic Hierarchy Process (AHP)

AHP is a method used to solve decision-making problems involving several interrelated criteria (6). This method organizes problems into a hierarchical structure, consisting of objectives, criteria, and alternatives, and allows for more transparent decision-making by calculating the relative weight of each element in the hierarchy. AHP has been widely applied in various fields, including urban planning, natural resource management, and environmental policy [14]. In the context of Go Green policies, AHP can be used to assess and select the best policy alternatives based on various relevant criteria, such as environmental, economic, social, and technological sustainability [6][15]. With AHP, each policy alternative can be compared objectively based on factors that are considered most important [16].

2.3. Research Objectives

This study aims to apply the AHP method in supporting the Go Green policy by evaluating policy alternatives based on four main criteria, namely Environmental Sustainability, Economic Sustainability, Social Sustainability, and Sustainability of Technology.

2.4. Research Stages

The stages of this research are as follows:

1. Determination of Criteria and Alternatives: The criteria used to assess Go Green policies include environmental, economic, social, and technological sustainability. The policy alternatives evaluated are the use of renewable energy, waste reduction, environmentally friendly transportation, and forest management policies.
2. Pairwise Comparison Matrix: Each criterion and alternative is compared using the AHP scale (6) to determine how important one element is compared to the other elements.
3. Matrix Normalization: The comparison matrix is normalized by dividing each element in a column by the number of that column, then averaging each row to obtain the relative weights.

Final Score Calculation: The final score is calculated by multiplying the criteria weights by the alternative weights for each criterion and summing the results

2.5. Data and Data Sources

The data in this study were obtained from literature related to Go Green policies, as well as assessments from experts who have expertise in the fields of environment, economics, and technology. The assessment was carried out using a paired comparison scale based on their experience and perspective.

2.6. System Design

The system design for implementing the analytic hierarchy process (AHP) method in supporting go green policies for environmental, economic, social and technological sustainability is illustrated in the following flow diagram.

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[Definisi Masalah] -> [Penyusunan Hierarki] -> [Matriks Perbandingan] -> [Normalisasi] -
> [Konsistensi] -> [Skor Akhir] -> [Pengambilan Keputusan]
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Figure 1. AHP Method Flowchart

3. RESULTS AND DISCUSSION

3.1. Paired Comparison Scale

Paired comparison scale is a method used in AHP to compare two elements of existing criteria or alternatives. Each element is given a numerical value to indicate how much preference or importance one element has over the other element (6)

Table 1. AHP Pairwise Comparison Scale

Mark	Explanation	Definition
1	Equally important (Equal Importance)	Both elements are considered to be equally important.
3	A little more important (Moderate Importance)	The first element is slightly more important than the second element.
5	Clear more important (Strong Importance)	The first element is clearly more important than the second.
7	Very important (Very Strong Importance)	The first element is much more important than the second element.
9	Absolutely more important (Absolute Importance)	The first element is absolutely more important than the second element.
2, 4, 6, 8	Mark between (Intermediate Values)	A comparative value used to indicate the degree of preference between existing values. (For example, 2 for slightly more important, 4 for more important, etc.)

3.2. Pairwise Comparison Matrix of Criteria

In the first step, a pairwise comparison matrix for environmental, economic, social, and technological sustainability criteria is prepared based on the perspective of the importance of each criterion [6]. The results of the comparison matrix show that environmental sustainability has the largest weight (56%), which shows that the Go Green policy should focus more on environmental protection [2][3].

Step 1: Pairwise Comparison Matrix

Pairwise comparison matrix is created to compare criteria and alternatives. The scale used is Saaty scale (1-9). Table 2 shows the pairwise comparison matrix for criteria based on the perceived importance of each criterion in supporting Go Green policy.

Table 2. Pairwise Comparison Matrix of Criteria

Criteria	Environment (K1)	Economics (K2)	Social (K3)	Technology (K4)
Environment (K1)	1	3	5	7
Economics (K2)	1/3	1	3	5
Social (K3)	1/5	1/3	1	3
Technology (K4)	1/7	1/5	1/3	1

Step 2: Matrix Normalization

Normalization is done by dividing each element in a column by the number of that column.

Normalization Formula:

$$\text{Normalisasi}(a_{ij}) = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

Criteria	K1	K2	K3	K4
Environment (K1)	0.56	0.65	0.56	0.44
Economics (K2)	0.19	0.22	0.33	0.31
Social (K3)	0.11	0.07	0.11	0.19
Technology (K4)	0.08	0.04	0.06	0.06

Step 3: Relative Weight Calculation

The relative weights are calculated by taking the average of each row of the normalization matrix.

Relative Weight Formula:

$$\text{Bobot}(w_i) = \frac{\sum_{j=1}^{n} \text{Normalisasi}(a_{ij})}{n}$$

Normalization of the comparison matrix produces weights for the following criteria: Environmental Sustainability (K1): 0.56, Economic Sustainability (K2): 0.28, Social Sustainability (K3): 0.12, and Technology Sustainability (K4): 0.04

3.3. Alternatif Pairwise Comparison Matrix for Environment Sustainability

The pairwise comparison matrix for policy alternative shows that renewable energy gets the highest weight compared to other alternative, followed by waste reduction ande environmentally friendly transportation. This is in line with research showing that the use of renewable energy can have a major impact on reducing carbon emissions and the sustainability of natural resources [17][9]. Table 3 shows a pairwise comparison matrix for policy alternatives based on environmental sustainability criteria.

Table 3. Pairwise Comparison Matrix of Alternatives for Environmental Sustainability

Alternative	Energy Renewable (A1)	Subtraction Waste (A2)	Friendly Transportation Environment (A3)	Management Forest (A4)
Renewable Energy (A1)	1	5	3	7
Waste Reduction (A2)	1/5	1	2	3
Transportation Friendly Environment (A3)	1/3	1/2	1	5
Management Forest	1/7	1/3	1/5	1

Step 4: Final Score Calculation
The final score is calculated by multiplying the criteria weights by the alternative weights for each criterion.

Final Score Formula:

$$\text{Skor Akhir}(A_i) = \sum_{j=1}^{n} w_j \times w_{ij}$$

The alternative weights for environmental sustainability are:

Alternative	Final Score
Renewable Energy (A1)	0.50
Waste Reduction (A2)	0.20
Environmentally Friendly Transportation (A3)	0.15
Forest Management (A4)	0.15

3.4. Final Score Calculation for Alternatives

After calculating the weight of the criteria and alternatives, the final score calculation for each alternative is done. Based on the calculation, the alternative with the highest score is Renewable Energy (A1), which scored 0.50. This shows that the policy of using renewable energy is the best choice and should be prioritized in supporting the implementation of the Go Green policy. This is in line with the results of research by (4), which shows that the transition to renewable energy is one of the main solutions to achieving environmental sustainability.

3.5. Discussion

The application of AHP in this study provides a clear and systematic picture of the policy alternatives that must be prioritized to achieve sustainability goals in the Go Green policy. The results show that Renewable energy prioritized over other policies, such as waste reduction or environmentally friendly transportation, because of its significant impact on reducing carbon emissions and the sustainability of natural resources [1][12].

4. CONCLUSION

This study shows that the application of the AHP method in supporting the Go Green policy, based on AHP analysis of four main criteria: environmental, economic, social, and technological sustainability, can help decision makers to choose the most appropriate policy alternative. Although other policy alternatives such as waste reduction and environmentally friendly transportation also important, renewable energy has the greatest potential in supporting global environmental sustainability and reducing the impacts of climate change.

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