DEVELOPMENT OF THE AHP METHOD TO SUPPORT GO GREEN POLICY FOR EEST SUSTAINABILITY

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Abstract

The escalating challenges of environmental degradation, climate change, and unsustainable resource consumption have prompted the need for integrated strategies to advance sustainable development. This study aims to develop a decision-making model based on the Analytic Hierarchy Process (AHP) to evaluate and prioritize Go Green policy alternatives across four critical sustainability dimensions: Environmental, Economic, Social, and Technological (EEST). The methodology employed structured pairwise comparisons with inputs from fifteen experts representing government, academia, non-governmental organizations, and the private sector. Findings reveal that the environmental dimension holds the highest priority weight (0.405), followed by economic (0.270), technological (0.190), and social (0.135) aspects. Among the policy alternatives assessed, Circular Economy and Waste Management ranked highest, reflecting its broad potential to enhance resource efficiency, reduce emissions, and foster community engagement. Despite the model's strengths, the study is limited by its reliance on a specific group of experts, which may restrict the generalizability of the results across broader stakeholder populations or geographic contexts. This research contributes to the fields of public policy, environmental management, sustainability assessment, and decision support systems by providing a structured, transparent, and participatory framework. The proposed AHP-based model offers a scalable approach for policymakers seeking to align environmental priorities with inclusive and innovation-driven development goals.

Keywords: *Analytic Hierarchy Process; Go Green Policy; Sustainable Development; Circular Economy; EEST Framework; Policy Prioritization*

1. INTRODUCTION

1.1 Background

Environmental degradation, climate change, and unsustainable consumption patterns have increasingly threatened ecosystems and human well-being worldwide. These global issues have urged governments and institutions to adopt sustainability as a central principle in policy development (Nations U, 2022). The Go Green movement is one response to these concerns, focusing on actions such as reducing carbon emissions, conserving biodiversity, and promoting the use of clean and renewable energy (UN E, 2019). However, designing effective sustainability policies is not simple. Policymakers must balance environmental goals with economic growth, social equity, and technological advancement (Elkington J & Rowlands I.H, 1999); (OECD, 2020).

1.2 Multidimensional Policy Challenges

Go Green strategies require consideration of multiple, often competing, factors. These include four key dimensions—Environmental, Economic, Social, and Technological (EEST)—that are interconnected:

- **Environmental**: Emission control, waste reduction, and ecosystem restoration.
- **Economic**: Cost efficiency, green investments, and job creation.
- **Social**: Public health, community equity, and participation.
- **Technological**: Clean technology adoption, digital infrastructure, and innovation.

Because of these complexities, traditional decision-making models often fall short. There is a clear need for multi-criteria decision-making frameworks that can handle trade-offs and integrate expert input (Mardani A et al., 2015); (Wahyuni D & Sridewi N, 2025).

1.3 Role of AHP in Sustainability Decision-Making

The Analytic Hierarchy Process (AHP)(Saaty T.L, 1980), offers a powerful multicriteria decision-making (MCDM) framework through structured pairwise comparisons. It enables stakeholders to rank conflicting priorities and quantify subjective judgments into measurable outcomes, thereby enhancing transparency and rationality in policy design (Saaty T. L, 2008); (Wahyuni D & Sridewi N, 2025).

1.4 Research Objectives

This study is motivated by the need for a structured and inclusive model to help policymakers evaluate and prioritize Go Green strategies. The specific objectives are to:

1. Develop an AHP-based model for evaluating Go Green policy alternatives.
2. Determine priority weights among environmental, economic, social, and technological criteria.
3. Identify optimal strategies that align with sustainable development principles.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Go Green and Global Sustainability Frameworks

Go Green initiatives are closely aligned with the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (affordable clean energy), SDG 11 (sustainable cities), SDG 12 (responsible consumption), and SDG 13 (climate action). These goals emphasize an integrative policy approach where economic growth is harmonized with environmental and social responsibilities (Nations U, 2015).

2.2 Decision Support Systems in Environmental Planning

MCDM tools such as AHP, TOPSIS, and Fuzzy AHP have been applied to sustainability-related decisions, including renewable energy site selection (Kahraman C et al., 2009), urban environmental planning (Falana et al., 2024), and smart city frameworks (Lu Y et al., 2020). Yet, few models holistically incorporate all four sustainability pillars within a Go Green context.

2.3 Applications of AHP in Environmental Policy

Previous research has validated AHP's utility in renewable energy prioritization (Kabak M & Dağdeviren M, 2014), risk assessment (Dey P.K & Ramcharan E.K, 2008), and waste management (Ho W, 2008). Its strengths lie in facilitating stakeholder engagement and ensuring internal decision consistency, though its application in multidimensional sustainability governance remains limited.

2.4 Research Gap

Although extensive research validates AHP's utility in green planning, most efforts have targeted specific sectors or limited dimensions (e.g., materials, energy, water). There remains a research gap in developing a comprehensive model that evaluates Go Green alternatives holistically, incorporating Environmental, Economic, Social, and Technological (EEST) criteria simultaneously (Wahyuni D & Sridewi N, 2025). Consequently, policymakers lack a transparent, multidimensional decision-support tool that captures trade-offs across EEST pillars.

3. RESEARCH METHODOLOGY

3.1 Research Design

This research is a **survey-based empirical study** using the Analytic Hierarchy Process (AHP), a widely accepted Multi-Criteria Decision-Making (MCDM) method. The structured procedure followed four main phases:

- Define the overall goal: Selecting the optimal Go Green policy alternative.

- Establish criteria and sub-criteria from literature and expert consultation.
- Conduct pairwise comparisons using Saaty's 1–9 scale.
- Calculate eigenvector-based priority weights and consistency ratios (CR).

Below is a sample of the pairwise comparison form used for expert judgment in AHP, utilizing Saaty's 1–9 scale.

Question	Which criterion is more important?	Intensity (1–9)
Q1	Environmental vs Economic	[ ]
Q2	Environmental vs Social	[ ]
Q3	Environmental vs Technological	[ ]
Q4	Economic vs Social	[ ]
Q5	Economic vs Technological	[ ]
Q6	Social vs Technological	[ ]

Instructions for Experts:
Use Saaty's scale:
1 = equal importance, 3 = moderate importance, 5 = strong importance, 7 = very strong, 9 = extreme.

3.2 Hierarchical Model

The AHP model is structured into three hierarchical levels:

- Goal: Identify the most effective Go Green strategy.
- Criteria:
  - C1: Environmental (e.g., Waste Reduction, Emission Control)
  - C2: Economic (e.g., Green Job Creation, Cost Efficiency)
  - C3: Social (e.g., Community Engagement, Public Health)
  - C4: Technological (e.g., Clean Technology Adoption, Innovation Readiness)
- Sub-Criteria: Selected based on relevance and validated through expert feedback. Each main criterion includes 2–3 sub-criteria reflecting its key aspects.

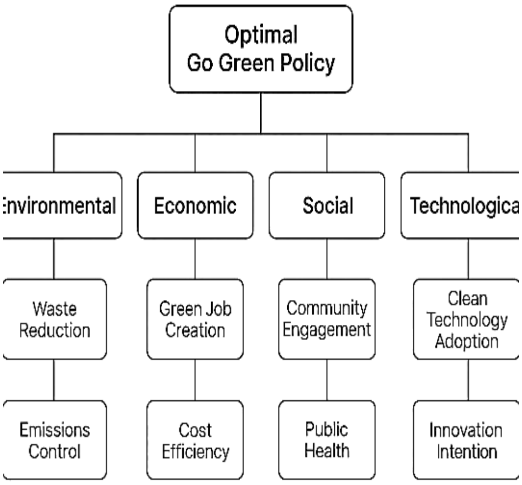

Figure 1: AHP Diagram

3.3 Data Collection

The study involved 15 domain experts representing academia, government, industry, and environmental NGOs. Data were collected via structured interviews and an online survey distributed over a two-week period. Experts conducted pairwise comparisons across four criteria and twelve sub-criteria using Saaty's fundamental scale. Participation was voluntary, and anonymity was maintained. A sample pairwise comparison questionnaire is provided in Appendix A.

Table 1. Sample pairwise comparison matrix (Saaty scale 1–9)

Criteria	Environmental	Economic	Social	Technological
Environmental	1	3	5	4
Economic	1/3	1	2	3
Social	1/5	1/2	1	2
Technological	1/4	1/3	1/2	1

3.4 Analysis Tools and Assumptions

The collected data were analyzed using Microsoft Excel 365 and Expert Choice v11.5, running on a Windows 11 PC with Intel Core i3 processor and 8GB RAM. AHP computations involved:

- Deriving priority vectors (eigenvectors) for each matrix.
- Calculating Consistency Index (CI) and Consistency Ratio (CR).
- Acceptable consistency was determined by CR < 0.10 (Saaty, 1980).

Assumptions:

- Experts are capable of providing rational, consistent judgments.
- The criteria and sub-criteria structure adequately represents the decision problem.
- The sample of 15 experts is sufficient for capturing diverse perspectives across sectors.

This methodology enables repeatability by other researchers under similar conditions using the same tools and structure.

4. RESULTS AND DISCUSSIONS

4.1 Priority Weights of Main Criteria

Based on pairwise comparisons from 15 experts, the priority weights for the four main criteria are as follows:

Criteria	Weight	Priority Rank
Environmental	0.405	1st
Economic	0.270	2nd
Technological	0.190	3rd
Social	0.135	4th

The environmental dimension emerged as the most influential, reflecting expert consensus on the urgent need for environmental interventions in sustainability planning. The Consistency Ratio (CR) for the matrix was 0.04, indicating acceptable consistency (< 0.1 threshold). Table 2 summarizes the weights, consistency indices (CI), and consistency ratios (CR) for each main criterion.

Table 2. Priority weights and consistency analysis of main criteria

Criteria	Weight	CI	CR	Consistency
Environmental	0.405	0.07	0.05	Acceptable
Economic	0.270	0.04	0.03	Acceptable
Technological	0.190	0.06	0.05	Acceptable
Social	0.135	0.05	0.04	Acceptable

The distribution of priority weights across the four main criteria is visualized in Figure 2.

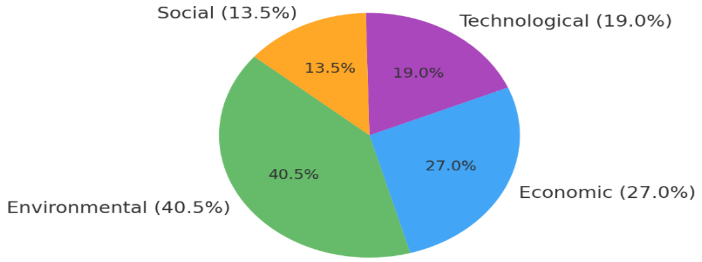

Figure 2: Priority Weights of Main Criteria

Pie chart of Main Criteria Weights (Environmental = 40.5%, Economic = 27.0%, Technological = 19.0%, Social = 13.5%).

4.2 Priority Weights of Environmental Sub-Criteria

Within the Environmental criterion, the sub-criteria were weighted as follows:

Sub-Criteria	Weight
Waste Reduction	0.216
Emission Control	0.120
Biodiversity Conservation	0.069

These results highlight the emphasis on tangible interventions such as waste reduction and emissions control.

4.3 Ranking of Policy Alternatives

The evaluated policy alternatives were ranked based on their global weighted scores using the AHP synthesis procedure. The top three alternatives are:

Policy Alternative	Final Score	Rank
Circular Economy & Waste Mgmt.	0.325	1st
Renewable Energy Adoption	0.278	2nd
Green Transportation Systems	0.243	3rd

The Circular Economy and Waste Management alternative ranked highest, indicating its broad appeal in addressing multiple sustainability aspects, particularly environmental and technological domains. The ranking of Go Green policy alternatives based on their global priority scores is illustrated in Figure 3 final AHP scores of Go Green policy alternatives.

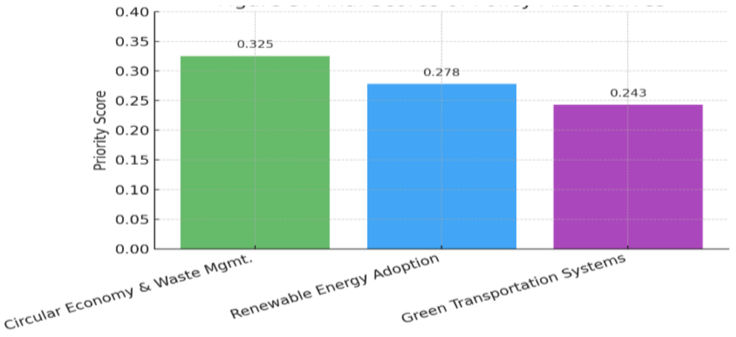

Figure 3: Final Scores of Policy Alternatives

4.4. Discussion

The findings of this study indicate that environmental sustainability is perceived as the most critical dimension when evaluating Go Green policy alternatives. This is consistent with previous research, such as Kabak and Dağdeviren (2014), who found that environmental criteria had the highest influence in renewable energy policy prioritization using AHP. The prioritization of environmental over social dimensions reflects a global emphasis on climate action and ecological preservation as outlined in the Paris Agreement and the UN Sustainable Development Goals (Nations U, 2015).

Moreover, the prominence of Circular Economy and Waste Management as the top-ranked strategy aligns with findings by Ho (2008) and Sharma et al. (2023), who emphasized that waste management initiatives not only reduce environmental harm but also generate economic benefits through resource efficiency and recycling. These strategies are supported by the triple bottom line framework, which emphasizes the balance of people, planet, and profit in sustainable development (Elkington J & Rowlands I.H, 1999).

Technological innovation, ranking third, reinforces prior findings that clean technologies act as enablers of systemic sustainability (Lu Y et al., 2020). However, the relatively low weight of the social dimension may indicate a gap in current stakeholder perspectives, highlighting the need for stronger civic participation and social inclusion in sustainability policymaking.

Overall, the study validates the effectiveness of AHP in integrating multidimensional sustainability criteria and providing structured, stakeholder-informed guidance. This supports its application in national and regional planning processes, particularly when trade-offs across environmental, economic, and technological factors are involved.

5. CONCLUSION

This study developed and applied an AHP-based decision model for prioritizing Go Green policies using four sustainability pillars: environmental, economic, social, and technological. Findings indicate that environmental factors are prioritized most heavily, with Circular Economy and Waste Management emerging as the top policy alternative. The approach demonstrated consistency and transparency, enabling structured input from a diverse group of experts.

Policy Recommendations:

- Policymakers should prioritize circular economy initiatives that offer environmental and economic returns.
- Future sustainability strategies should integrate technological innovation as a cross-cutting enabler.
- Broader stakeholder engagement is needed to reflect more inclusive social perspectives.

Governments and institutions may adopt this AHP framework to guide national or regional green development plans.

LIMITATION AND STUDY FORWARD

Despite its strengths, this study has several limitations. The analysis is based solely on expert judgments, which may carry inherent biases and reflect specific stakeholder perspectives. The sample size of 15 experts, though diverse, may not fully capture the broader societal view or the evolving priorities in different regional contexts. Additionally, the study did not include real-time data on environmental or economic performance indicators, which could complement expert evaluations. Future studies could expand the expert panel to include community voices and integrate fuzzy logic or hybrid AHP–TOPSIS approaches to address uncertainty and enhance robustness. Longitudinal studies could also be employed to assess how sustainability priorities shift over time. Furthermore, integrating geospatial analysis or real-time sustainability metrics would improve model precision and practical application.

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