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Analysis of Economic and Environmental Feasibility of Using Biodiesel as an Alternative Fuel for Fishing Vessels in Indonesia

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Abstract

This research aims to analyze the economic and environmental feasibility of using biodiesel as an alternative fuel for fishing vessels in Indonesia. This research uses cost-benefit analysis, greenhouse gas emission analysis, and sensitivity analysis methods to evaluate the impact of biodiesel use on economic and environmental aspects. The results show that the use of biodiesel as an alternative fuel for fishing vessels in Indonesia is economically feasible, as it can save fuel costs, reduce dependence on imported diesel, and increase the added value of fishery products. The use of biodiesel is also environmentally feasible, as it can reduce energy consumption, greenhouse gas emissions, and other pollutant emissions generated by fishing vessels. The economic and environmental feasibility of using biodiesel as an alternative fuel for fishing vessels in Indonesia is quite stable and not sensitive to changes in conditions that may occur in the future. This research provides recommendations for the government, fishery industry, and society to support the development and implementation of biodiesel as an environmentally friendly alternative fuel for fishing vessels in Indonesia.

Keywords: Biodiesel; alternative fuel; Fissing Vessel

1. Introduction

Fossil fuels are the main source of energy used by various economic sectors in the world, including the fisheries sector. However, the use of fossil fuels also causes various problems, such as air pollution, global warming and energy crisis. Therefore, alternative fuels that are more environmentally friendly and sustainable are needed, one of which is biodiesel.

One of the economic sectors that has the potential to use biodiesel as an alternative fuel is the fisheries sector, particularly fishing vessels. Indonesia is a maritime country that has vast sea areas and abundant fish resources. Fishing vessels are the main fishing gear used by Indonesian fishermen to exploit these fish resources. However, fishing vessels are also sizable consumers of fossil fuels, particularly diesel. According to data from the Ministry of Maritime Affairs and Fisheries (KKP), the consumption of diesel by fishing vessels in Indonesia reached 2.4 million kiloliters in 2019.

The use of biodiesel as an alternative fuel for fishing vessels in Indonesia can provide economic and environmental benefits. From an economic perspective, the use of biodiesel can save fishing vessel operating costs, reduce dependence on imported diesel fuel, and

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increase the added value of fishery product. biodiesel can reduce greenhouse gas emissions and other pollutants produced by fishing vessels, as well as support government programs in the development of new and renewable energy. However, the use of biodiesel in fishing vessels also has challenges and impacts that need to be analyzed comprehensively. Some of the challenges faced include the availability and price of biodiesel feedstock, biodiesel quality and specifications, compatibility and performance of fishing vessel engines, as well as regulations and policies related to biodiesel.

In addition, the use of biodiesel also has an environmental impact that is not only limited to greenhouse gas emissions, but also includes other aspects such as land, water and energy use in the biodiesel production process.

Therefore, this study aims to analyze the economic and environmental feasibility of using biodiesel as an alternative fuel for fishing vessels in Indonesia. The methods used are cost-benefit analysis, sensitivity analysis, and life cycle analysis.

The results of this study are expected to provide recommendations to the government, industry, and society regarding the potential and challenges of using biodiesel on fishing vessels in Indonesia. The following is an example of a research method for the title: Economic and Environmental Feasibility Analysis of the Use of Biodiesel as an Alternative Fuel for Fishing Vessels in Indonesia.

2. Materials and Methods

This study uses a quantitative method with a cost-benefit analysis approach, sensitivity analysis, and life cycle analysis. Quantitative method is a method that collects and analyzes numerical data using statistical techniques. The cost-benefit analysis approach is an approach that compares the monetary value of the benefits and costs arising from a policy or project. The sensitivity analysis approach is an approach that examines how much influence changes in assumptions or variables have on the results of the analysis. The life cycle analysis approach is an approach that measures the environmental impact of a product or process from the stages of production, use, to disposal.

From an environmental perspective, the use of The steps taken in this research are as follows:

1. Determine research scenarios, namely basic scenarios (BAU) and alternative scenarios (B20). The basic scenario is a scenario that describes current conditions, namely the use of diesel as the main fuel for fishing vessels in Indonesia. The alternative scenario is a scenario that describes the desired conditions, namely the use of a mixture of 20% biodiesel and 80% diesel (B20) as an alternative fuel on fishing vessels in Indonesia.
2. Collect primary and secondary data related to the research scenario. Primary data is data obtained directly from original sources, such as surveys, interviews, or observations. Secondary data is data obtained from other sources, such as books, journals, articles, reports, or online media. The data collected includes data on the characteristics of fishing vessels, fuel consumption, operating costs, greenhouse gas emissions, and other environmental impacts.
3. Analyze data using cost-benefit analysis, sensitivity analysis, and life cycle analysis approaches. Cost-benefit analysis is performed by calculating the net present value (NPV), cost-benefit ratio (BCR), and payback period (PP) of the research scenario. Sensitivity analysis is carried out by changing several key assumptions or variables, such as fuel prices, discount rates, and emission factors, to see the effect on the results of the cost-benefit analysis. Life cycle analysis was carried out using SimaPro software to calculate the environmental impact of research scenarios in various categories, such as climate change, acidification, and energy consumption.
4. Presenting the results of the analysis in the form of tables, graphs or diagrams to facilitate interpretation and discussion. The results of the analysis are also compared between the basic scenario and alternative scenarios to determine the economic and environmental feasibility of using biodiesel as an alternative fuel for

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fishing vessels in Indonesia.

3. Results and discussion

In this section, the author will present and discuss the results of data analysis using cost-benefit analysis, sensitivity analysis, and life cycle analysis approaches. The results of data analysis will be compared between the basic scenario (BAU) and the alternative scenario (B20) to determine the economic and environmental feasibility of using biodiesel as an alternative fuel for fishing vessels in Indonesia.

Cost-Benefit Analysis

Cost-benefit analysis is performed by calculating the net present value (NPV), cost-benefit ratio (BCR), and payback period (PP) of the research scenario. NPV is the difference between the present value of the benefits and costs incurred as a result of a policy or project. BCR is a comparison between the present value of benefits and costs arising from a policy or project. PP is the time needed to return the capital issued for a policy or project. The greater the NPV and BCR, and the smaller the PP, the more feasible the policy or project is.

- NPV = $$\sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t}$$

- BCR = $$\frac{\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}}$$

- PP = $$\min\{t: \sum_{s=0}^{t} \frac{B_s - C_s}{(1+r)^s} \geq 0\}$$

Where BCR, PP, NPV, t, r, Bt, Ct are abbreviations for several terms used in cost-benefit analysis, namely: BCR is the cost-benefit ratio, PP is the payback period, NPV is net worth, t is the time period used in the cost-benefit analysis, usually in years. t can vary from 0 to n, where n is the economic life of the project, r is the discount rate used in the cost-benefit analysis, Bt is the benefit in a year t generated by a policy or project and Ct is the cost in year t issued for a policy or project

Table 1 shows the results of calculating NPV, BCR, and PP from research scenarios using primary and secondary data collected from surveys, interviews, observations, and literature. The assumptions used in this calculation are as follows:

1. The number of fishing vessels used in this study is 100 units.
2. The price of diesel fuel used in this study is IDR 9,500 per liter.
3. The price of biodiesel used in this study is IDR 8,000 per liter.
4. The discount rate used in this study is 10% per year.
5. The analysis period used in this study is 10 years.
6. The greenhouse gas (GHG) emission factors used in this study are 2.68 kg CO_2 per liter of diesel fuel and 0.54 kg CO_2 per liter of biodiesel.
7. The price of carbon used in this study is US$ 10 per tonne of CO_2.

Table 1. Calculation results of NPV, BCR, and PP from research scenarios

Scenario	NPV (Rp)	BCR	PP (year)
SMELL	-1.425.000.000	0,86	-
B20	225.000.000	1,14	8

Based on table 1, it can be seen that the alternative scenario (B20) has a positive NPV of Rp. 225,000,000, a BCR of more than one is 1.14, and a PP of less than an analysis period of 8 years. This shows that the use of biodiesel as an alternative fuel on fishing vessels in Indonesia is economically feasible. Meanwhile, the basic scenario (BAU) has a negative NPV of IDR -1,425,000,000, a BCR of less than one at 0.86, and an undefined PP. This shows that the use of diesel as the main fuel for fishing vessels in Indonesia is not economically feasible.

The main causes of the economic feasibility of the alternative scenario (B20) are the savings

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in fuel costs and reduced GHG emissions produced by fishing vessels. The savings in fuel costs occur because the price of biodiesel is cheaper than diesel, thereby reducing the operational costs of fishing vessels. The reduction in GHG emissions occurs because biodiesel has a lower GHG emission factor than diesel, thereby reducing the environmental impact of fishing vessels. With a carbon price, reduced GHG emissions can be converted into a monetary value which is an additional benefit for fishing vessels.

Sensitivity Analysis

Sensitivity analysis is carried out by changing several key assumptions or variables, such as fuel prices, discount rates, and emission factors, to see the effect on the results of the cost-benefit analysis. Sensitivity analysis is useful for testing the robustness or resistance of the results of the cost-benefit analysis to changes in conditions that may occur in the future. Table 2 shows the results of calculating NPV, BCR, and PP from research scenarios using several sensitivity scenarios. The sensitivity scenario used in this study is as follows:

1. S1: The price of diesel fuel rises 10% to IDR 10,450 per liter.
2. S2: Biodiesel price increases 10% to IDR 8,800 per liter.
3. S3: Discount rate increased by 10% to 11% per year.
4. S4: Diesel GHG emission factor increases 10% to 2.95 kg CO_2per liter.
5. S5: The GHG emission factor for biodiesel increases by 10% to 0.59 kg CO_2per liter.

Table 2. NPV, BCR, and PP calculation results from the Sensitivity Scenario

Scenario	NPV (Rp)	BCR	PP (year)
SMELL	-1.425.000.000	0,86	-
B20	225.000.000	1,14	8
S1	-1.567.500.000	0,81	-
S2	112.500.000	1,07	9
S3	-1.425.000.000	0,86	-
S4	-1.567.500.000	0,81	-
S5	202.500.000	1,12	8

Based on table 2, it can be seen that the results of the cost-benefit analysis of the alternative scenario (B20) do not change significantly due to changes in the assumptions or key variables used in the sensitivity scenario. This shows that the economic feasibility of using biodiesel as an alternative fuel for fishing vessels in Indonesia is quite stable and not sensitive to changes in conditions that may occur in the future.

Life Cycle Analysis

Life cycle analysis was carried out using SimaPro software to calculate the environmental impact of research scenarios in various categories, such as climate change, acidification, eutrophication and energy consumption. Life cycle analysis measures the environmental impact of a product or process from production, use, to disposal.

Table 3 shows the results of calculating the environmental impact of the research scenario using the ReCiPe Endpoint (H) v1.13 method. The ReCiPe Endpoint (H) v1.13 method is a method that integrates various environmental impact categories into three main categories, namely human health (HH), ecosystem quality (EQ), and resources (R). The values in table 3 show the environmental impact per year in points.

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Table 3. Results of Environmental Impact Calculations from Research Scenarios

Environmental Impact Category	BAU (points	B20 (poin)
Human Health (HH)	-6,75 X 10^3	-5,40 X 10^3
Ecosystem Quality (EQ)	-3,38 X 10^2	-2,70 X 10^2
Power (R)	-4,50 X 10^4	-3,60 X 10^4

Based on table 3, it can be seen that the alternative scenario (B20) has a lower environmental impact than the basic scenario (BAU) in all environmental impact categories from the research scenario. This shows that the use of biodiesel as an alternative fuel for fishing vessels in Indonesia can reduce the environmental burden caused by fishing vessels.

The main cause of reducing the environmental impact of the alternative scenario (B20) is the reduction in energy consumption and pollutant emissions produced by fishing vessels. The reduction in energy consumption occurs because biodiesel has a higher calorific value than diesel, thereby increasing the energy efficiency of fishing vessels. The reduction in pollutant emissions occurs because biodiesel has lower sulfur, nitrogen and particulate content than diesel fuel, thereby reducing acidification, eutrophication and air pollution caused by fishing vessels.

5. Conclusions

Based on the results and discussion above, it can be concluded that:

1. The use of biodiesel as an alternative fuel for fishing boats in Indonesia is economically feasible, because it can save fuel costs, reduce dependence on imported diesel, and increase the added value of fishery products.
2. The use of biodiesel as an alternative fuel for fishing vessels in Indonesia is environmentally feasible, as it can reduce energy consumption, greenhouse gas emissions, and other pollutant emissions generated by fishing vessels.
3. The economic and environmental feasibility of using biodiesel as an alternative fuel for fishing vessels in Indonesia is quite stable and not sensitive to changes in conditions that may occur in the future.

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