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***Research paper***

# The Alternative Model Policies to Reduce the Impact of Climate Change

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**Abstract**

Currently, climate change is one of the highlights from the world's attention because of the impact of climate change in life. Research related policies to reduce these impacts are still not widely practiced, especially in Indonesia. The purpose of this study was to develop a model of policy alternatives that can be used as a reference in the response to climate change impacts on environmental and economic aspects. There are 2 methods used in this research, first is a dynamic simulation model using VENSIM software and the second is model of policy analysis using Multi Criteria Decision Analysis (MCDA) method with software PRIME for developing policy alternatives. The results showed that policy that based on economy, namely the reduction of the amount of fuel, is a policy that can reduce CO2 emissions significantly compared with the policy that based on environment is the addition of green open space.

***Keywords***: *Climate change, Environment, Policy analysis*

## 1. Introduction

Climate change is a global phenomenon will have a great impact for human life. Adverse impact mostly caused by human activities, namely a lack of awareness in doing things that harm the environment. For example, not pay attention to the preservation of the environment, illegal logging and land clearing by burning that have the environmental impact. The occurrence problem today is global warming that causing climate change.

The characteristics of the phenomenon of climate change among others, are rising average temperatures, the hydrological cycle is disrupted, resulting in a longer dry sea-son and the rainy season more intense but shorter. In addition to these factors, the nature of climate change appears today is global warming that causes the ice at the north pole and the south pole to melt causing rising sea levels that implicated in the occurrence of rob in the coastal region [1].

In Indonesia, the impact of extreme weather can be seen from the incompatibility of the changing seasons in various regions. Some regions suffer from drought, while other areas were flooded. This makes a lot of negative ef-fects, especially for farmers who can no longer determine the harvest season so it makes some of crop failure. This also impacts on health and the environment. Research conducted by [2], stated that there has been a climate change in Jakarta. If these circumstances are let it without any action, then the environmental condition for future generations become damaged. One of the efforts to minimize these impacts is to implement a policy so that people realize climate change is happening.

To conduct research on the climate change experi-ment a bit difficult to do, because it takes a long time and substantial funds, so that the approach is to create a model. In addition, policy-related research to reduce the impact of climate change, especially in Indonesia is still not many deal done. Research has been conducted policy-related, for example a model policy on e-desa [3], while the environ-mental policy related to the general environmental policy, such as Dynamics of Policy Networks in Organic Farming [4]. The purpose of this study was to develop a model of policy alternatives that can be used as a reference for the prevention efforts climate change impacts on environmen-tal and economic aspects. Environmental aspects in this research is the impact on $CO_2$ emissions which is also related to temperature and precipitation, whereas the economic aspects is the economic losses due to illness cases caused by $CO_2$ emissions.

## 2. Materials and Methods

Before using the model for policy analysis, modelling for simulation analysis of the impact of climate change on the environment and the economy is done by using the simulation of system dynamics models using VENSIM software. After the simulation is done, continued with the development of model to create and analyze the policy alternatives using PRIME (Preference Ratios In Multi attribute Evaluation) software. In the system dynamics models, the analysis of the relationship between variables used regression analysis. Software used for regression analysis is MINITAB. In this article, the discussions are focused on the development of policy alternatives based on multy criteria decision analysis (MCDA) using PRIME software

The data used are secondary data from documents ob-tained from the Central Bureau of Statistics, Ministry of Environment, Ministry of Health, and the Meteorology and Geophysics Agency. The data used are time series data from 2000 to 2014. The researcher also conducts focus group discussion to give the qualitative weighting in multi-criteria analysis.

## 3. Results and Discussion

Before conducting policy analysis, dynamic system simula-tion is done first to obtain predictive values that will be used as a basis for policy analysis. Simulations carried out until the year 2025 at the modification of the rate of popu-lation growth, a reduction in fuel, reduction in the number of vehicles and increase of green open space. Impacts are analyzed, that is to CO2 emissions, cases of dengue, diar-rhea and economic losses. The simulation results are ana-lyzed until 2025. Stock flow diagram (SFD) of a dynamic system is shown in Figure 1.

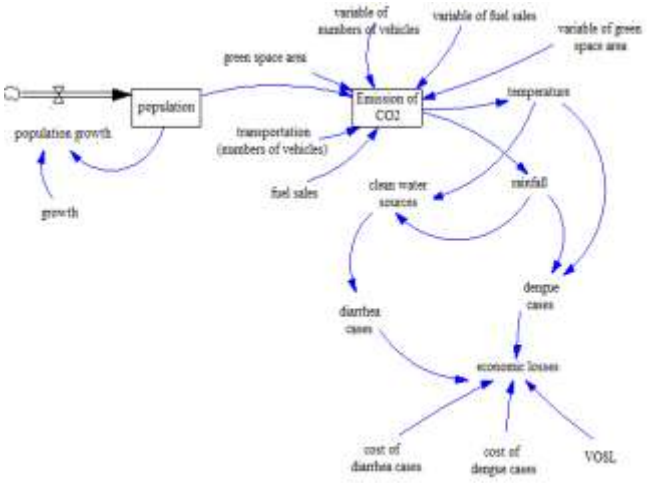


**Figure 1:** The SFD of Climate Change Impact on Econom-ic and Environmental

The increase in CO2 is assumed comes from the popu-lation, the number of vehicles, fuel sales and industry. However, the industry's influence on the increase of CO2 is not direct, but are represented in the sale of fuel. The num-ber of existing industries in Jakarta cannot represent the contribution of industry in CO2 ambient concentration, since not all of these industries emit CO2.

Increased CO2 in the air will be led to the rise in temperature and rainfall, so that the cause of climate change. Climate change will have an impact on the reduction of clean water sources, which can also lead to increase of diarrhea, while on the other hand, with increased rainfall and temperatures will impact the increase in dengue disease. The existence of cases of these diseases significantly, would cause economic losses.

Based on the simulation results that have been done with the dynamic system, the values obtained become in-puts for policy analysis model by using software PRIME. In addition, the qualitative assessment based on focus group discussion was conducted in relation to give the weighting to the development of this policy alternatives. The stages are carried out on the development of an alternative model of policy [5] namely:
Determining the criteria (sub-attributes) as well as sub-criteria that will affect the alternative measures taken. The criteria used in this research are the criteria for environmental, social and economic. Sub-criteria selected from the variables contained in the dynamic systems that has been simulated before. The criteria and sub-criteria are entered into PRIME, environmental criteria with a sub-criteria from variable amount of emissions, social criteria with a sub-criteria from variable incidence of diarrhea and dengue cases, and economic criteria with a sub-criteria from variable economic loss.
Determination of policy alternatives that is used as the reference scenario and should be weighted. There are three policy alternative scenarios are used as follows:
Scenario I: if there is nothing to do (Do Nothing)
Scenario II: environment -based policy, namely the increase in the area green space
Scenario III: economy-based policy, namely the reduction of the amount of fuel
Determination of the weights to the criteria that have been determined, based on the average value of the dynamic simulation results for the period 2000-2025 for each variable. "Do Nothing" alternative is used as a baseline, assuming we do not do anything, there is no policy whatsoever. "Environment-based policy" alternative, that is the increasing of the green space areas, while the "economy-based policy" alternative "economy-based policy" alternative, namely the reduction of the amount of fossil fuel.
Then do the process of policy alternatives and the weighting in the PRIME software. Based on the output of PRIME, the dominant policy alternative is the assumption of economy-based policy (Figure 2).

| | Do Nothing | Environmental Based | Economic Based |
|---|---|---|---|
| Do Nothing | o | | ● |
| Environmental Based | | o | ● |
| Economic Based | ● | ● | o |

**Figure 2**: Dominance of alternative climate change policy

In this case the economic-based policy that is the re-duction of fuel sales up 10%. Based on the PRIME output of decision rules, possible loss for alternative assumptions economic-based policy is the smallest which is -0.197 (Fig-ure 3). Thus the alternative economic-based policies have the possibility of loss or damage which is the smallest com-pare to the criteria of environmental, social, and economic.

| | Maximax | Maximin | Central Values | Minimax Regret | Possible Loss |
|---|---|---|---|---|---|
| Do Nothing | | | | | 1.000 |
| Environmental Based | | | | | 1.000 |
| Economic Based | √ | √ | √ | √ | -0.197 |

**Figure 3**: The decision rules of alternative climate change policy

The analysis that is based on the value of the interval between the three policy alternative assumptions, the "Do Nothing" policy, economic-based policy and environment-based policy is depicted in Figure 4. Based on the PRIME software output, the economic-based policy alternatives has the highest interval with a maximum value (1-1), the alternative policy of "Do Nothing" (0-0) and environmental -based policies (0-0.0823).

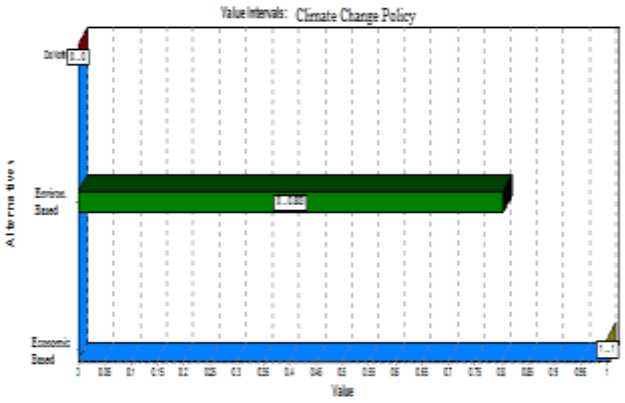


**Figure 4:** The results of interval value of alternative climate change policy

When assessed by weighting, the social criteria have the highest weight, followed by environmental and economic criteria for climate change policy alternative (Figure 5). The social criteria represented by the sub-criteria of diarrhea and dengue can not be regulated in a policy. From the dynamic system simulation results, it is known that sales of fossil fuels affect the cases of diarrhea and dengue. In the development of alternative policy models, the sale of fuel is a sub-criteria of economic criteria.

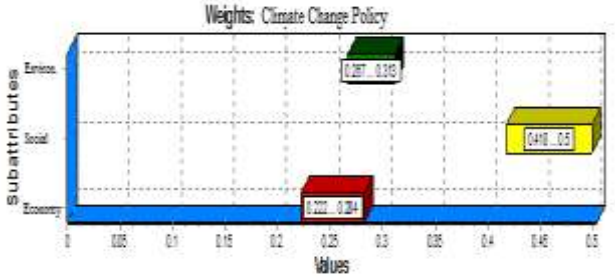


**Figure 5:** The results of weighting on alternative climate change policy.

The implications of the PRIME results, is the climate change policy alternative is best to use an economic-based policy alternative. That is, the need for a reduction in fuel that could potentially effect higher emissions. Fuel sales reduction can be done by reduction or limitation of the number of vehicles, the emissions associated control the use of fuel, for example from industry and so on. Control of CO2 emissions can be done partly by changes in the technology used in transportation and industry or the policies of the emission control.

Example of reduction in CO2 emissions from industry is research that has been done by [6], that is strategies to curb CO2 emission from cement industry through carbon capture and storage to avoid release of CO2. For reducing the number of vehicle related fuel usage, can be done by optimizing traffic control to reduce fuel consumption [7]. In addition, the need for monitoring of the government's emissions released by industry. In this case the Ministry of Environment of Indonesia has made the preparation of the technical guidelines for measuring air pollutant emissions [8].

The environmental-based policy, namely the expan-sion of green space, in this study cannot reduce emissions significantly. This is due to the amount of CO2 emissions produced from fuel is quite high, while the increase in the area green space is not enough to absorb CO2 emissions. Thus, better fuel reduction policies to reduce CO2 emissions rather than the expansion of the green space areas. It is also in line with the results of the regression analysis, where the greatest CO2 emissions are influenced by fuel sales. In addition, the spacious green open space in Jakarta is very worrying, only 9.9% of 30% it is supposed to be [9] and based on the research that has been done by [10], which mention that the optimum area of green open space in Ja-karta is 19.62%. To determine a policy of green open space in Jakarta, may be able to do research as has been done by [11] that is a division of green spaces based on the quality factor.

The application of economic-based policies must be implemented concurrently with the CAC (Command and Control) policy-based in the form of the establishment of the Ambient Quality Standards and Emission Quality Standard. The determination of Ambient Quality Standards need to be implemented in order to maintain air quality for human being and other air pollution receptors so that it is not has negatively affected by the contaminants. In addition, the Jakarta Provincial Government should also set Emission Quality Standard, which is the standard that should be set before the economic-based policy can be enforced. Based on the fact there are still many Emission Quality Standard for industrial activities undetermined, then government should establish policies relating to the Emission Quality Standard for the industry activities.

## 4. Conclusion

The impact of climate change policy can be demonstrated by using a model of policy analysis with various scenarios. Economy-based policy, namely the reduction of the amount of fuel, is a policy that can reduce co2 emissions significantly compared with the environment-based policy is the addition of the green space areas. The addition of the green space areas spacious should be high enough when it will have an impact on the reduction of CO2 emissions.

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