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The Influence of Production Factors on the Productivity of Weather Modification Technology Services at the Center for Weather Modification Technology

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Abstract

This study aims to determine the effect of flight costs, seedlings and production factors on TMC productivity, as well as the effect of production factors simultaneously on TMC productivity, as well as the effect of TMC productivity on TMC benefits. The object of this research is the Central Bureau of Weather Modification Technology customers. Center for Weather Modification Technology with its address at Gedung Geostech 820, Kawasan Puspitek, Setu, South Tangeran. Analysis tools using SPSS. The results of the study are the cost of flights and seedling costs not significantly positive effect on TMC productivity, HR costs have no significant negative effect on TMC productivity, also the three independent variables simultaneously have a significant positive effect on TMC productivity, but TMC productivity is found to be significantly positive effect on benefits TMC.

Keywords *: Production, Flight Costs, Seedling Costs, HR Costs, TMC Productivity*

1. INTRODUCTION

1.1. Background

Electrical energy in this modern an computerized era is very important. To support community activities, electrical energy must be available and sufficient. The increasing need for electrical energy from society causes the need for generators capable of generating large amounts of electrical energy. Electrical energy is generated at power generating centers including hydroelectric power plants (PLTA). One aspect of hydropower operation is scheduling the water released to be converted into electrical energy. The hydro plant scheduling problem involves forecasting water availability and scheduling water in the reservoir that is released during certain scheduling intervals, depending on the reservoir capacity (Wood & Bruce, 1996).

Hydroelectric power plant operations generally various studies have been carried out. Pratama conducted research on reservoir optimization to analyze daily reliable discharge and optimal power in hydropower plants using the mass curve method (Pratama, 2011). Several studies use different methods in optimizing hydropower reservoirs such as: Genetic Algorithm (Cheng et al., 2009 and Asfaw & Hashim, 2011), Evolutionary Algorithm (Jothiprakash & Arunkumar, 2013), Particle Swarm Optimization (Ghimire & Reddy, 2013), and Non Linear Optimization (Catalão et al, 2010).

To support the availability of water so that electricity supply can meet community needs, one of the efforts made by the government or electricity producers is to implement Weather Modification Technology (TMC). TMC is one of the technologies owned by the government under the auspices of the Agency for the Assessment and Application of Technology (BPPT). TMC is an effort to intervene by

aim to maximize water resources stored in reservoirs in order to obtain maximum energy generation or economic benefits. Optimal hydropower operation or scheduling can provide benefits, including maximizing the value of water resources and minimizing generation costs. One of the main factors that influences the electrical energy that can be generated by hydropower is the availability of water in tandom ponds (reservoirs). The availability of water in this reservoir is influenced, among other things, by: water supply (inflow) obtained from surrounding rivers, rainfall, evaporation, as well as water use for generation or other purposes.

Regarding optimization of hydropower reservoir operations, several methods are used

Technology Assessment and Application. Based on these two PPs, several users asked about the relatively high increase in TMC operational costs. In 2018, BBTMC did not carry out any Weather Modification Technology Services activities to increase Rainfall.

2. RESEARCH METHODS

2.1 Research Design

This research uses a causal quantitative approach. Sugiyono (2011:15) explains that a causal quantitative approach is research that looks for the relationship between one variable and another variable that has a cause and effect relationship.

2.2. Place and Data Source

The research process carried out by the author was located in the Soebagyo Building, Puspitek Serpong Area, Weather Modification Technology humans in controlling water resources in the atmosphere to increase rainfall (rain enhancement) and/or reduce rainfall intensity (rain reduction) in certain areas to minimize natural disasters caused by climate and weather by utilizing weather parameters.

Starting in 2008, TMC Services use PNBP rates based on Indonesian Government Regulation (PP) Number 36 of 2008 concerning Types and Tariffs for Non-Tax State Revenues Applicable to the Agency for the Assessment and Application of Technology. Then in 2015 the PP was updated with PP RI Number 6 of 2015 concerning Types and Rates of Non-Tax State Revenues Applicable to Entities

The conditions specified in this research are:

a) Weather Modification Technology (TMC) services which are only related to increasing rainfall to fill lakes/reservoirs

b) Seeding that only uses salt seeding material, while services related to smoke thinning and reducing rainfall and the use of seeding material other than salt are not analyzed.

Based on the conditions that have been determined, the samples in this study were 70 activity samples.

2.5 Analysis Tools

The data analysis used in this research is multiple regression analysis, namely to determine the factors that influence rainfall results using multiple linear regression analysis.

2.6 Analysis Model

Figure 1: Analysis model of the influence of flight cost variables, seed material costs and human resource costs on TMC productivity

Center. The data source for this research was obtained from data held by TMC, namely data on flight costs, seed material costs, human resource costs, TMC productivity and TMC benefits.

2.3 Population

The population is all TMC activities carried out by the Center for Weather Modification Technology for services in an effort to increase rainfall intensity for filling lakes/reservoirs from 1989 to 2017, totaling 106 activities. Data is taken from the TMC Operational Activity Report for additional Rainfall.

2.4 Sample

The sampling technique is purposive sampling, namely determining sampling by determining special characteristics.

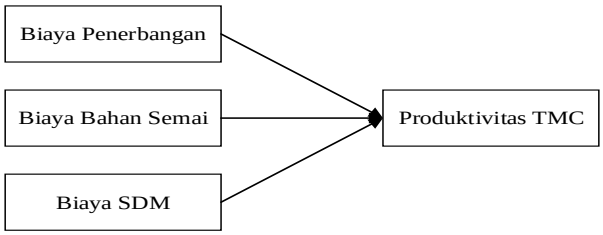
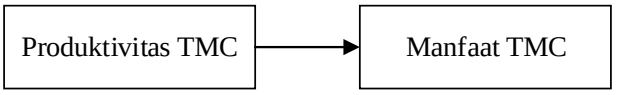


Figure 3.4 Influence of TMC productivity on TMC benefits



The independent variables in this research are flight costs (X1), seedling material costs (X2), and human resource costs (X3), while the dependent variables are total TMC productivity (Y1) and

TMC Benefits (Y2). This research uses statistical analysis tools, so that in the analysis there are 2 analysis models, namely the influence of flight cost variables, seedling material costs and human resource costs on TMC productivity and the influence of TMC productivity on TMC benefits. The analysis model for this research is presented in Figures 1 and 2.

3. RESULTS AND DISCUSSION

3.1 Partial Test Results (t-Test) of the Influence of Production Factors on TMC Productivity, Model 1

The partial test is used to test whether each independent variable has a significant effect on the dependent variable or not. Calculations to determine the independent variable (X) against the dependent variable (Y) partially, by comparing the significant t count with a significance level of 5%, namely 0.05. Ho is rejected and Ha is accepted if the calculated t is significantly smaller than the t table.

Table 1. T-Test Model 1

Variable	Sig. t count	Sig 5%	Notes
X_1	0,346	0,731	H_a rejected
X_2	0,483	0,631	H_a rejected
X_3	0,779	0,097	H_a rejected

Source: SPSS

Based on the table above, it can be concluded that the flight cost indicator (X1); cost of seedling materials (X2); and human resource costs (X3) each have an insignificant effect on the dependent variable, namely TMC productivity (Y1).

Calculations to determine the magnitude of the influence of each independent variable (X) on the dependent variable (Y) can be seen from the coefficient values from the results of multiple linear regression analysis as in table 2.

Table 2. Multiple Regression Coefficient Value

Variable	Coefficient	Sig. T count	Sig. 5%
C	3.727	2.902	0.05
Y1	0.021	0.346	0.73
X2	0.056	0.483	0.63
X3	-0.137	-1.686	0.09

Source: SPSS

Based on table 2 it can be concluded that:

a. The influence of flight cost indicators (X1) on TMC productivity (Y1).

The results of the analysis show that the value of the multiple linear regression coefficient for flight costs (X1) is 0.021, meaning that if this indicator is increased by 1%, the TMC productivity level will increase by 2.1%.

b. Influence of seeding material cost indicators (X2) on TMC productivity (Y)

The results of the analysis show that the multiple linear regression coefficient value for seedling material costs (X2) is 0.056, meaning that if this indicator is increased by 1%, the TMC productivity level will increase by 5.6%.

c. The influence of human resource indicators (X3) on TMC productivity (Y)

The results of the analysis show that the value of the multiple linear regression coefficient for human resources (X3) is -0.137, meaning that if this indicator is increased by 1%, the level of human resources will decrease by 13.7%

3.2 Partial Test Results (t-Test) Effect of TMC Production on TMC Benefits, Model 2

The partial test is used to test whether each independent variable has a significant effect on the dependent variable or not. Calculations to determine the independent variable (X) against the dependent variable (Y) partially, by comparing the significant t count with a significance level of 5%, namely 0.05. Ho is rejected and Ha is accepted if the calculated t is significantly smaller than the t table.

3.2 Table 3. T Test Model 2

Variable	Sig. t count	Sig 5%	Notes
Y_1	3,502	0,00	H_a accepted

Source: Appendix 2, results of computer analysis using SPSS

Based on the table above, it can be concluded that TMC productivity (Y1) has a significant effect on the dependent variable, namely TMC benefits (Y2).

Calculations to determine the magnitude of the influence of the independent variable (X) on the dependent variable (Y) can be seen from the coefficient values from the results of multiple linear regression analysis as in table 4 below:

Table 4. Single Regression Test Model 2

Variable	Coefficient	Sig. t count	Sig. 5%
C	2,80	3,502	0,01
Y_1	84,657	4,535	0,01

Source: SPSS

Based on table 4, it can be concluded that the influence of TMC productivity indicators (Y1) on TMC benefits (Y2). The results of the analysis show that the simple linear regression coefficient value for TMC productivity (Y1) is 84.65, meaning that if this indicator

is increased by 1%, the level of TMC benefits will increase by 84.65%.

3.3 F TesT

Simultaneous testing is a comprehensive test to determine simultaneously the multiple linear regression coefficient of production factor variables (X) on TMC productivity (Y1). This test is carried out by comparing the sig value. F count with sig. 5%.

Table 5 F Test Model 1

Dependent Variable	Independent Variable	Adjusted R Square	Sig. F count
Y_1	X_1,X_2,X_3	0,006	1,144

Source: SPSS

Based on Table 5, it can be concluded that the flight cost indicator (X1); cost of seedling materials (X2); and HR costs (X3) simultaneously have an insignificant effect on TMC productivity indicators.

The contribution of the independent variable to the dependent variable can be seen from the multiple determination coefficient, which is 0.006. This means that the influence of the independent variables (X1,

3.4 Discussion

The research results show that flight costs have a significant positive effect on TMC productivity. Based on the interview results, these results are related to cloud seeding which depends on local weather conditions. The following are recommended local weather conditions at the time of flight:

a. Analysis of weather elements on the surface

The surface weather elements analyzed are

temperature and humidity conditions at the first observation in the morning, namely at 07-00 and 10.00 WlB. From these two weather elements, it can be analyzed regarding the possibility of convectiveness as an indication and potential for the growth of cumulus type rain clouds as well as orographic processes as a contribution of local conditions to the growth of rain clouds. During the activity, the air temperature range generally varies for all observation stations, but in general there is a difference of ≥ 40 C. This value indicates the potential for convective processes to occur.

a. Upper layer wind analysis

Besides local surface conditions, local upper wind conditions are also analyzed. This upper wind analysis is carried out to see the development of local wind patterns that are formed. From this wind analysis it appears that wind patterns generally vary between confluent and divergent.

b. Analysis of X-band radar data

X-band radar is used to monitor cloud growth in the target area. X-band radar with a Doppler system can monitor cloud movements and the water content in the clouds.

The research results show that the cost of seedling materials has a significant positive effect on TMC productivity. Based on the results of interviews, this condition is caused by global weather also having an influence on cloud seeding using seeding materials, including:

a. Humidity

Air humidity is a measure of the relative value of water vapor content in the air, where the higher the humidity value, the more saturated the air mass will be.

b. Liability (Index Totals)

Liability is a measure used to determine the level of lability/instability of the atmosphere, where the greater the lability value, the more unstable the atmosphere and the easier it is to transport air masses from low levels to higher levels. The lability value for the target area is generally 40, in this value range the atmospheric conditions are quite unstable.

c. Precipitation / Water is capable of Precipitation

Precipitation is a value obtained from the accumulation of weather parameters which shows the probability of the amount of rainfall that can occur.

d. Gradient Wind

Gradient wind is wind at an altitude of around 1000 meters (3000 feet) above the earth's surface which describes the flow of air in the lower atmosphere which is no longer affected by the friction of the earth's surface. At this level there is no influence of local winds or topographic influences such as sea breeze, valley breeze and so on.

e. Satellite Imagery

Satellite images provide information on cloud cover and types in the atmosphere. Satellite imagery used for analysis in TMC implementation activities in the infrared channel. The infrared data channel is based on temperature. The more

the colder the temperature, the color of the object becomes whiter. On the other hand, the hotter the temperature, the blacker the color of the object.

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cyclone areas of maximum cloud cover and movement of cloud bases and tops. Data from observations and measurements will be analyzed and the results will determine a seeding decision. From the results obtained, a decision will be made, if the weather conditions are favorable, seeding preparations will be carried out, such as seeding time, location, height of the seeding area and the amount of material or type of cloud to be sown as well as the Flight Scientist on duty.

The research results show that TMC productivity has a positive and significant impact on TMC benefits. According to Nasution (2004), as an effort to implement environmental preservation, every cloud seeding activity always includes monitoring environmental aspects, which includes water quality which includes physical and chemical conditions and observing general environmental conditions. As has been implemented in several river basins, increasing rainfall through TMC is already routine work. Addition of reservoir/lake water is carried out almost every year in the Saguling watershed area. By maintaining the reservoir water volume through TMC, the environmental balance between water demand and supply can be maintained. As an archipelagic country located on the equator between two continents and two oceans, Indonesia has a source of water vapor which becomes clouds that bring rain. It is still possible to add additional rainfall at the beginning or end of the rainy season to increase rainfall in certain areas. Bulk addition

rain with TMC requires rainwater storage such as reservoirs or reservoirs where excess water can be distributed during the dry season.

3.5 Conclusion

Based on the research results, it can be concluded that:

a. Flight costs have an insignificant positive effect on TMC productivity

b. The cost of seedling materials has an insignificant positive effect on TMC productivity.

c. HR costs have an insignificant negative effect on TMC productivity

d. Production factors simultaneously have an insignificant effect on TMC productivity.

e. TMC productivity has a significant positive effect on TMC Benefits.

f. There are other factors or variables that can influence the TMC results.

3.4 Suggestions

Suggestions for variables such as flight costs, seedling material costs, human resources, TMC productivity and TMC benefits, researchers suggest that:

a. For further research, researchers should look for/examine other variables.

b. BBTMC can further improve TMC services, especially TMC services for increasing rainfall/filling

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