

## **MULTIPE REGRESSION AND PRODUCTIVITY ANALYSIS OF MODJOPANGGUNG SUGAR FACTORY**

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### **Abstract**

*Modjopanggung sugar factory is located in Tulungagung has problem in sugar production and productivity that less effective. The question of this research is about some factor of productivity, how to increase sugar production, and productivity. The purpose is to know the most significance factor that influence sugar production and to measure productivity of Modjopanggung in 2010. Major steps of this research consists of problem formulation, theoretical foundation, model formulation, data collection and analysis, and conclusions and recommendations. In this research, multiple regression model was used in which sugar production acts as the dependent variable and factories sugarcane own field wide, farmer sugarcane field wide, sugarcane sucrose content average from factories sugarcane field, sugarcane sucrose content average from farmer sugarcane field, factories efficiency, truck unit, yesterday sugarcane remnant, sugar milling day amount, milling capacity as independent variable, and in productivity measure use labor, sugarcane material, capital, fuel, electricity as input and income from sugar and tetes as output. Data collection was done through interviews and observations to factory. The result is amount of truck unit and farmer sucrose content is statistically the most significant variables. The model resulted in an adjusted r square 0.997 mean 99.7%. The result of the t test indicated that there is no mean difference between the forecast and the actual data of sugar production. Productivity in 2010, ratio of partial output and input all more than 1 mean output can cover input, but in multifactor and total factor less than 1 mean addition of input productivity factors actually can not cover by output factor, with lowest partial output factor is electricity and highest partial output factor is sugarcane material. The suggestion is better policy to increase truck unit and farmer's sugarcane content and effectively in labor quality, sugarcane dividend with farmer, capital usage, fuel alternate and usage, electricity efficiency. Purpose. The objectives of this research are To know the most important factor that expectedly influence material supply that is factories sugarcane own field wide, farmer sugarcane field wide, sugarcane sucrose content average from factories sugarcane field, sugarcane sucrose content average from farmer sugarcane field, factories efficiency, truck unit, yesterday sugarcane remnant, sugar milling day work, milling capacity, and the combination, and know how important their fluctuation influence sugar production and to measure productivity of Modjopanggung sugar factory. Design/methodology/approach. The step of this research, first problem formulation, theoretical foundation, model formulation, data collection and analysis, and conclusions and recommendations. In this research use multiple regression model that use sugar production as dependent variable, and factories sugarcane own field wide, farmer sugarcane field wide, sugarcane sucrose content average from factories sugarcane field, sugarcane sucrose content average from farmer sugarcane field, factories efficiency, truck unit, yesterday sugarcane remnant, sugar milling day amount, milling capacity as independent variable, and in productivity measure use labor, sugarcane material, capital, fuel, electricity as input and income from sugar and tetes as output. Methodology of research is by interview and observation to factory. Findings. The result is amount of truck unit and farmer sucrose content is the most significant among all variable to increase sugar production with positive sign, mean increase in them also increase sugar production, adjusted r square 0.997 mean 99.7% of sugar production can explained by result of independent variable, t value in 0.1298 that still inside acceptance area, mean no difference in forecast and reality of sugar production. Productivity in 2010, ratio of partial output and input all more than 1 mean output can cover input, but in multifactor and total factor less than 1 mean addition of input productivity factors actually can not cover by output factor, with lowest partial output factor is electricity and highest partial output factor is sugarcane material. Research*

limitations/implications In the future In dependent variable can use as much as possible ,because spss program will eliminate most significant independent variable directly, productivity analysis can include more input factor, after discuss with lecturer cause when input productivity in fact bigger or lower than value that use less input factor, factory can make better anticipation in their strategy. Practical implications. Modjopanggung sugar factory will get more suggestion to effective ness their expense to increase sugar production and efficiency in productivity. Social implications. Modjopanggung Factory as old BUMN factory, have social responsibility such as free kindergarten education to their labor's kid and recruit labor from society around factory in harvest time, hopefully when production and income increase they can buy more sugarcane from farmer,more incentive to farmer that become member in the future, then mean need more labor. Originality/value. The most statistically significant independent variables affecting sugarcane production.

**Keywords:** Sugarcane production, multiple regressions, productivity analysis, PG Mojopanggung  
**Category:** Operations

**Introduction**

Sugar as one of agriculture manufactured product is one of important commodity in daily life. Cause sugar can consume directly in daily household or as food and beverage industries ingredient. Sugar commodity position as one of SEMBAKO with increase in demand along with increase in population growth and food manufactured industry make sugar factories hold strategic position and vital to keep economic stability especially domestic sugar price stability. Domestic demand quantity in sugar commodity that increase cannot supply by sugar factories production capacity that decrease instead. In 1994-1998 sugar production decrease about 40% from 2,454 million ton to be 1,392 million ton, while domestic sugar demand increase about 6% from 2,94 million ton to be 3,13 million ton in same time .Government alternative solution is sugar import .Sugar import increase from 130.000 ton become 1,8 million ton ,in 1994-1998 even reach 2 ton. Since 1998-2003 domestic sugar production increase, in 2002 domestic sugar production reach 1,75 ton.(Santosa, Eddy Bambang.2008.Analisis Kualitas Nira dan Bahan Alur Proses Untuk Pengawasan Pabrikasi Di Pabrik Gula.Pasuruhan:P3GI).

Increase in market demand influence sugar factories development in Indonesia. One of old sugar factory is PG. Modjopanggung, East java. Build by Netherlands government in 1852, now Modjopanggung sugar factory is part of PT.Perkebunan Nusantara X that produce sugar. As sugar production PG.Modjopanggung need sugar cane as material as sugar production basic ingredient to suffice production process and fulfill production target. It is important to keep

sugarcane supply because sugarcane can only harvest in certain season. It make The sugar factories to get and arrange sugarcane supply to reach sugar production target annually, Usually factories have their own sugar cane field or cooperate with sugarcane farmer around factory to sell their harvest to factory that have contact and give them credit before.

**Methodology**

Major steps in this final project consist of problem formulation, theoretical foundation, model formulation, data collection and analysis, and conclusions and recommendations as shown in figure below:

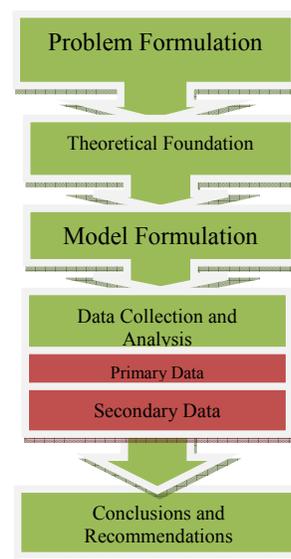


Figure.1. Research methodology

### Problem Formulation

As mentioned in Chapter 1, this final project has two major objectives. The first objective is to identify significant variables of sugar production in PG. Modjopanggung. The second objective is to measure and analyze productivity of sugar production in this plant 2010.

### Theoretical Foundation

There are several topics discussed in this review. These include sugar production, multiple liner regression, and productivity measurement. Review on sugar production mentioned raw materials, and sugar. Review on regression provided basic ideas about model formulation and statistical testing of the model parameters. Review on productivity measurement presented several formulas to calculate partial and total productivity.

### Model Formulation

Model formulation is mainly about building the proposed multiple linear regression model in which the dependent and independent variables are identified. In this model, the dependent variable is yearly sugar production. There 11 independent variables proposed in this model. These are factory's field wide, farmer's field wide, factory sugarcane content, farmer sugarcane content, truck unit, milling day amount, milling capacity/day, factory efficiency, previous day sugarcane remnant, milling capacity/year

### Data Collection and Analysis

Interview with department staff that relate to sugar production, like tanaman, pengolahan department to consult about annual report of sugarcane production variable, operational strategy and chemical process in sugar production and production data as secondary data with pembukuan, kepegawaian, department to consult about financial report, and production expense.

Observation in penimbangan dan penggilingan department to observe sugar production from sugarcane entering factory to sugar made packed in sack,

Next, Raw data about Dependent and Independent variable is gathered, To calculate the project result, data collection is needed. Data collections divide into primary data and secondary data:

#### Primary Data

Author gained primary data by copy variables data from milling and plantation department of Modjopanggung sugar factory

After all data is gathered next is choose the most important variables by consult with Modjopanggung representation staff and lecturer, predict important variable with low probability of error.

#### Variable selection

Raw data sample materials generally comprise of data below and will be reduced

- Independent variable

First chose variable from raw data that comprise of: farmers sugarcane fields wide (Ha), factory sugarcane wide (Ha), Sugarcane supply (Ku), Farmer sugarcane sucrose content (%), factory sugarcane sucrose content, (%) Hablur (Ku), SHS (Ku), Tetes (Ku), Brix NPP, % Pol NPP, HK NPP, KNT, sugarcane husk content, HPB total, PSHK, winter sugarcane sucrose content, factory efficiency, sugarcane sucrose content factor, inclusive milling capacity, exclusive milling capacity, A finished hours, B finisher hours, finished hours % milling hours

- Dependent variable

Sugar production data from 1998-2010 as Y variable

### Secondary data

Productivity factor of Modjopanggung in 2010, collected from accountant and human resource staff, author use data like annual report, energy expense, and employee salary, the other data taken from internet.

Table.1. Productivity input and output

Input	
Labor	Rp
2011	27.087.754.574
2010	31.928.988.369
2009	32.440.245.731
2008	24.992.880.892
sugarcane material	total

2008	56908010584
2009	72378493229
2010	60494117467
Capital Rp	
2009	56014495718
2010	52.712.581.045
2011	49.238.605.584
Energy Rp	
2009	1.316.364.914
2010	1.570.807.210
2011	745.307.191
Electricity Rp	
2008	1.093.378.106
2009	742.544.967
2010	929.274.914
2011	582.785.430
total input	
2009	152.554.616.056
2010	138.438.754.464
output	
finished unit	total
2008	83.319.770.325
2009	107.425.455.978
2010	90.003.420.228

Author use previous year income of sugar and tetes as output and chose only all employee salary, capital, solar fuel, sugarcane Material (based on dividend of factory and farmer), and electricity cost as input

**Conclusions and Recommendations**

Based upon the results of data analysis, several conclusions will be drawn. These conclusions include the significant independent variables affecting sugar production and the results of productivity measurement. Following to these conclusions, a few recommendations will be proposed. These recommendations are expected to useful for PG Modjopanggung to manage their sugar production as well as improve their productivity.

**III.Results**

The equation result is:

$$Y = -254338.6 + 4.257 x_5 + 38599.873 x_4 + e$$

**Result interpretation:**

- **Adjusted R-squared**  
From regression result data, we get adjusted R-squared value to the number of 0.997 this thing shown that 99,7% from dependent variable movement variation (sugar production) can explained totally by independent variable (factories sugarcane own field wide, farmer sugarcane field wide, sugarcane sucrose content average from factories sugarcane field, sugarcane sucrose content average from farmer sugarcane field, truck unit, sugar milling day amount ,sugar milling capacity, factory efficiency, yesterday sugarcane remnant , ,and the combination of sugar milling day amount and sugar milling capacity)
- **Coefficient interpretation**

$\beta_5 = 4.257 \Rightarrow$  When amount of truck unit increase 1%, sugar production will increase about 4.257 quintal (with ceteris paribus assumption, another independent variable constant)

$\beta_4 = 38599.873 \Rightarrow$  When farmers sugarcane sucrose content increase 1%, sugar production will increase about 38599.873 quintal (with ceteris paribus assumption, another independent variable constant)

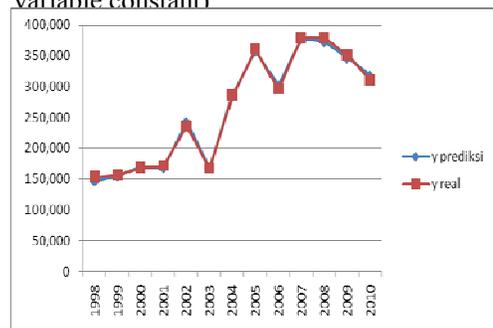


Figure.2.Comparison of forecast and reality of sugar production of Modjopanggung

Table.2.Productivity Calculation

<b>Partial measure</b>	2008	2009	2010
<u>Output</u>	3,333,740,143	3,311,487,122	2,818,862
Labor			
<u>Output</u>			
sugarcane material	1,464,113,215	148,421,791	1,487,805
<u>Output</u>			
Capital		2	1,707,437
<u>Output</u>			
Fuel		8,160,765,669	5,729,756
<u>Output</u>			
Electricity	762,039,864	1,446,719,872	9,685,338
<b>Multifactor measure</b>			
<u>Output</u>			
labor+capital+material		0,667931	0,620133
<u>Output</u>			
labor+material+fuel		1,012,158	0,957545
<b>Total measure</b>			
<u>Output</u>			
Input		0,704177	0,650132

- Ratio of labor and output of sugar decrease continually but still above 1 which mean output value effective to cover labor cost
- Ratio of sugarcane cost and output of sugar above 1, output value still effective to cover sugarcane expense
- Ratio of capital and output of sugar above 1, output value still effective toward annual capital
- Ratio of electricity cost and output of sugar above 1 and highest, output value still effective to cover electricity cost
- Ratio of combination of labor, capital, and material and output less than 1, factory should efficiency one or better all that cost cause output can not cover them well
- Ratio of combination of labor, fuel, and material and output less than 1, factory should efficiency one or

better all of that cost cause output can not cover them well

- Globally ratio of input and output less than 1 hopefully factory make their costs and expenses more efficiency or increase income from sugar and tetes production

### Conclusions

Several conclusions regarding sugar production and productivity can be drawn. First, the multiple linear regression model involving significant variables is as follows.

- $Y = -254338.6 + 4.257 x_5 + 38599.873 x_4 + e$

Where:

- Y = annual sugar production (in 100 kilograms)
- X4 =Farmer sugarcane content (in percent)

- X5 =number of truck (unit)

This model has an adjusted r-square of 0.997 which means that the 99.7 percent of variation of the annual sugar production can be accounted by variation of farmer sugarcane content and the number of truck. In addition, this model has an error value of 0.003 or three percent of unexplained variation. In other words, there are other independent variables which are unknown in this final project.

Second, the regression coefficient of X4 is 38599.873 with a positive sign and X5 is 4.257 also a positive sign. This implies that truck unit and farmer sugarcane sucrose are independent variables that have most significant influence to the dependent variable. In other words, an increase of 1% of truck increases 425.7 kilograms and an increase of 1% of farmer sugarcane sucrose content increases 3,859,987.3 kilograms of sugar.

Third, productivity measures for total, multi factor, and partial for 2010 are as follows:

Total factor productivity 2010

- output:input = 1:1,538149929

Multi factor productivity 2010

- output: (employee + capital + material) = 1 : 1.6126
- output:(employee + material + fuel) = 1 : 1.0443

Partial productivity measure 2010

- output: employee = 2.8189 : 1
- output: material = 1.4878 : 1
- output: capital = 1.7074 : 1
- output: fuel = 57.2976 : 1
- output: electricity = 96.8534 : 1

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