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ANALYSIS OF FACTORS AFFECTING PRODUCTION EFFICIENCY IN THE MANUFACTURING INDUSTRY

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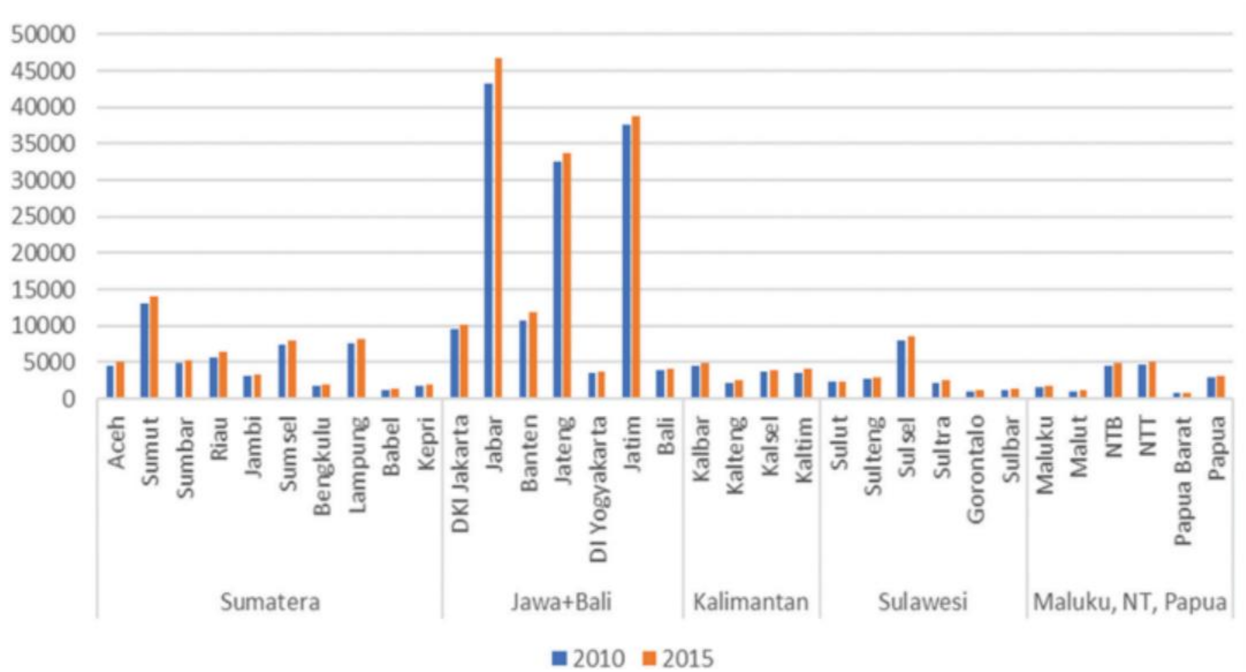
Abstract: *The analysis of production factors in PT X's industrial processing is crucial for increasing inter-sector value addition and making a substantial contribution to the regional GDP in economic development. Collaborations between regions can lead to the concentration of processing industries or industrial agglomerations in Central Java. Regions with potential access to natural resources as raw materials and skilled human resources can benefit from economies of scale, economic location, and nearby labor to boost regional economic growth. Optimizing the substitution of production factors is considered in input usage, with a substitution elasticity of 1. Production efficiency is measured through technical, price, and economic efficiency, along with returns to scale. This research aims to analyze input usage and include exogenous factors like industrial agglomeration. The analysis method uses Stochastic Frontier Analysis (SFA) with Frontier 4.1 software estimation. The study's findings reveal significant positive influences of capital (X1), raw materials (X3), labor (X3), wages per labor (X4), and agglomeration (AG). The conclusion underscores the proportional addition of production factors to achieve optimal production scale results. Updating production machinery faces challenges from modern technological developments that enhance production outcomes. Improving human resource quality through training and formal education, making it labor-intensive, helps absorb a substantial workforce.*

Keywords: *Processing industry; Industrial Agglomeration; Industrial Production; Efficiency*

1. Introduction

According to Kuncoro (2012), industrialization has gradually evolved, leading to changes in the economic sector structure, specifically a decline in the agricultural sector's contribution and an increase in the manufacturing sector. The manufacturing sector can enhance the value added in other sectors by absorbing labor, thereby promoting regional economic development. The contribution of 17 sectors to Central Java's Gross Regional Domestic Product (GRDP) from 2010 to 2015 is illustrated in Figure 1.



Source: Central Java BPS, 2018

Figure 1. Central Java Province GRDP 2010-2015 (Billion Rupiah)

Sjafrizal (2008) mentioned that countries have one or more economic growth centers that positively impact strong potential regions, spreading to weaker regions (trickle-down effect) and producing complementary products.

Kuncoro (2012) also pointed out that the production process through inter-regional collaboration can lead to the concentration of industries or industrial agglomeration, potentially benefiting from economies of scale, location advantages, and aligned labor forces in driving regional economic growth.

Additionally, according to Suryanto (2012), foreign companies experience greater productivity growth compared to local companies. Romdhoni's research (2015) indicates that manufacturing labor has a more significant impact on industrial output formation compared to non-manufacturing labor, while capital factors have a negative effect. Riyardi's study (2015) suggests that industries reliant on foreign direct investment (FDI) do not enjoy technological advancements. On the other hand, industries reliant on domestic investment (DMDN), which are labor-intensive, face challenges due to low-quality human resources and a lack of attention to modern technology.

Based on the above background, it is essential to analyze the factors influencing manufacturing production and production efficiency in districts and cities within Central Java province. The aim is to optimize the utilization of manufacturing production factors by employing a Stochastic Frontier Analysis approach (Arif, M., & Sismar, A. (2024)).

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2. Research Method

Industrialization

According to Arsyad (2010), the modernization process of the economy encompasses all economic sectors with added value, thereby driving other sectors to increase regional income. Long-term economic development with high and sustainable regional economic growth can enhance employment and income levels while contributing to GRDP growth (Arsyad, L. (2010).

Factors Influencing Manufacturing Industry

Dewi (2023) defines production factors as elements used in the production process. Commonly used production factors include production capital, production raw materials, production labor, production labor wages, and industrial agglomeration. Production activities involve processes, processing, and transforming production factors of the manufacturing industry into economic value benefits and economic value-added (Dewi, R., Hamid, R. S., Sismar, A., Bachtiar, R. E. P., & Moonai, S. (2023)).

Production Capital (X1)

According to Riyanto (2001), production capital refers to goods or money used to produce production goods or outputs. Capital used to finance the overall production process significantly impacts the output process of the manufacturing industry.

Production Raw Materials (X2)

Kholmi (2003) explains that production raw materials processed in the production process are the main materials for industrial production activities. The use of raw materials in production processes impacts sales through price increases and halts production if unavailable.

Production Labor (X3)

Kusnendi (2003) states that labor is a critical factor in production activities, consisting of two groups: the workforce and non-workforce.

Production Labor Wages (X4)

According to Simanjuntak (2011), wages are the compensation received per worker for their services in the production of goods or services in the industry. Production labor wages function as a decent living for humanity and production expressed in monetary terms set according to agreements, laws, regulations, and paid based on a work agreement between industry leaders and labor.

Industrial Agglomeration (AG)

According to Kuncoro (2012), when agglomeration in a region reaches maximum economic scale, expansion beyond that point only generates negative effects (agglomeration diseconomies) for the agglomeration area. The occurrence of industrial agglomeration has specific advantages, such as economies of scale (large-scale production) and cost-saving benefits: 1.) Internal benefits of manufacturing industry; 2.) Localization benefits (Localization Economies); 3.) External benefits

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(urbanization benefits). The emergence of agglomeration economies in an area will drive economic growth in that region due to production efficiency creation.

According to Sbergami (2002), agglomeration can be measured in several ways, such as the proportion of the number of industrial sector workers in districts/cities to the total number of industrial sector workers in a province.

$$Indeks\ Ballasa.: \frac{\frac{Eij}{\Sigma j\, Eij}}{\frac{\Sigma i\, Eij}{\Sigma i\, \Sigma j\, Eij}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Information:
Eij = Total workforce in the sector district/city level industry;
Ei= Total workforce at district/city level;
Ej = Total workforce in the sector
provincial industry; = Total power

Function of Production

According to Soekartawi (2003), measuring the production function using a stochastic frontier approach assumes that the production function is transformed into a natural logarithm linear form (ln). Therefore, manufacturing production can be expressed using the regression model equation for manufacturing industry production:

$$LnY = \beta0 + \beta1\ LnX1 + \beta2\ LnX2 + \beta3\ LnX3 + \beta4\ LnX4\ \varepsilon i \ \ldots\ldots\ldots\ldots(2)$$

Frontier Production Function

Soekartawi (2003) explains that the frontier production function represents the use of factors influencing manufacturing production broadly. The model for the frontier production function used to measure the manufacturing industry production process is expressed as follows:

$$Y = f\ (Xi\ \beta)\ \exp\ \varepsilon i \ \ldots\ldots\ldots\ldots(3)$$

Where:
β = Parameters to be calculated.
Xi = Input factors influencing manufacturing production.
$\varepsilon i = vi + ui$.

According to Soekartawi (2003), stochastic frontier production f (X) exp εi has several symmetric distributions to capture the random influence of measurement errors and exogenous disturbances that cause core placement of deterministic f (X) to vary between manufacturing industries.

Measurement Approach with Stochastic Frontier Analysis (SFA)
Soekartawi (2003) states that there are two commonly used statistical measurement methods: non-parametric and parametric. Parametric measurement methods include Stochastic Frontier Analysis

(SFA) to calculate production efficiency in manufacturing industries. The parametric measurement approach has an advantage with stochastic frontier involving a disturbance term representing disturbances or errors in measurement and exogenous factors beyond the control of factors influencing the production process (Jhingan, M. L. (2008).

According to Soekartawi (2003), there are two forms of error terms: v represents random errors unrelated to inefficiencies, while u represents inefficiencies in measurement. The stochastic frontier method assumes both of these and is assumed to be independently and identically distributed (iid).

$$\text{Inefficiency} = 1 - \exp(-Ui) \quad \text{...........(4)}$$

Soekartawi (2003) mentions that conventionally, random error components are assumed to follow a normal distribution. The assumption of inefficiency distribution or non-negative random variables can be considered as a half-normal model, an exponential model, a truncated normal model, and a gamma model. Technical details relate to the distribution (Kholmi, M. (2003).

Technical Efficiency (ET)
According to technical efficiency refers to the efficient use of production factors if the factors used result in maximum production. The ratio of observed production output for the i-th manufacturing industry relative to the potential production output defined by the frontier function of available production input factors (Riyanto, B. (2001). Xi used to define the technical efficiency of the i-th manufacturing industry is as follows:

$$ET_i = \frac{Yi}{\exp(Xi\beta)} = \frac{\exp(Xi\beta - ui)}{\exp(Xi\beta)} = \exp(-ui) \quad \text{................................(5)}$$

Price Efficiency (EH)
Explains that price efficiency shows the relationship between production costs and production output. Price efficiency can be achieved by maximizing profits, which means equalizing the marginal production of each production factor with the production price. Price efficiency can be achieved when the marginal production value is equal to the production price of the respective production factors. The level of price efficiency can be calculated using the following equation (Kuncoro, M. (2012).:

$$EH_i = \frac{Yi}{\exp(Xi\beta)} = \frac{Yi}{Yopt} \quad \text{...................................(6)}$$

This means that price efficiency is the level of comparison between production output Yi and optimal production output.

Economic Efficiency (EE)

According to Soekartawi (2003), economic efficiency refers to the condition of a production process that uses production inputs and costs as minimally as possible to produce a certain amount of output or to achieve maximum output in manufacturing industries.

$$E = ET \times EH \quad \ldots\ldots\ldots\ldots\ldots\ldots(7)$$

Where: EE = Economic Efficiency; ET = Technical Efficiency; EH = Price Efficiency.

Return To Scale (RTS)
Soekartawi (2003) explains that return to scale (RTS) or the scale of operation is important to determine the combination of production factor usage. There are three possibilities for the value of return to scale:

Decreasing Returns to Scale: when (b1 + b2 + …. + bn) < 1. In this case, it can be interpreted that the proportion of increase in production factors exceeds the increase in production.

Constant Return to Scale: when (b1 + b2 + …. + bn) = 1. In this case, it can be interpreted that the proportion of increase in production factors is proportional to the increase in production.

Increasing Return to Scale: when (b1 + b2 + …. + bn) > 1. In this case, it can be interpreted that the proportion of increase in production factors will result in greater production.

Regional Economy
According to Jhingan (2008), development occurring in a particular location is an attraction for economic development in the region, leading to concentration of development in that area. This concentration is caused by the potential factors in the growth center area, which strongly influences and at the same time hampers development in surrounding areas, known as the polarization effect or concentration (Jhingan, M. L. (2008).

Data Types and Sources
This research uses data secondary in the form of panel data with observation period 2010 – 2015 (6 years) of Large Industrial Statistics and Medium Volume I published by Central Java BPS.

Data Analysis
According to Soekartawi (2003), measuring the production function using a stochastic frontier approach assumes that the production function is transformed into a natural logarithm linear form (ln), as follows:

$$LnY = \beta 0 + \beta 1\ LnX1 + \beta 2\ LnX2 + \beta 3\ LnX3 + \beta 4\ LnX4\ \varepsilon i \quad \ldots\ldots\ldots\ldots\ldots\ldots(8)$$

The total output of manufacturing production (Y) is influenced by production capital (K), production raw materials (BB), production labor (L), production labor wages (U), and εi is the error or disturbance term. This approach aims to optimize the use of factors influencing production and the efficiency of manufacturing industries (Simanjuntak, P. (2011).

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3. Results and Discussion

Production Function Regression Panel data regression results with using the Fixed Effects approach Model (FEM).

Table 1. Regression Results for Variable Yang Affecting Industrial Productiontri

Variabel	Coefficient	Std. Error	t-Statistic	Prob.
LOG(K)	0.040366	0.007680	5.256301	0.0000
LOG(B)	0.632026	0.025843	24.45594	0.0000
LOG(L)	0.398313	0.064402	6.184816	0.0000
LOG(U)	0.346151	0.025576	13.53405	0.0000

Source: Eviews 9.1, 2018 (processed)

Detection of Deviations from Classical Assumptions

Multicollinearity Detection

There is no relationship between variables free which has a value of more than 0.8. Therefore, it can be concluded that it is free of sufficient multicollinearity bother.

Tabel 2. Tabel Residual Correlation Matrix

	LOG(K)	LOG(B)	LOG(L)	LOG(U)
LOG(K)	1.000000	0.666845	0.631801	0.315572
LOG(B)	0.666845	1.000000	0.540241	0.407709
LOG(L)	0.631801	0.540241	1.000000	0.155925
LOG(U)	0.315572	0.407709	0.155925	1.000000

Source: Eviews 9.1, 2018 (processed)

Autocorrelation Detection

In the regression results of the Durbin Watson is 2.0607 with n = 210 then Durbin-Watson values are obtained in the table with an alpha level of 5%, namely dL = 1.7176 and dU = 1.8199, 4-dU = 2.1801 and 4-dL = 2.2824. Detection results autocorrelation shows that the value Durbin-Watson is on the fence accept Ho or no autocorrelation both positive and negative (Sjafrizal. (2008).

Heteroscedasticity Detection

All variables have values probability above the 5% significance level (0.05). Therefore, it can be concluded that the model in this research has free from heteroscedasticity (Riyardi, A. (2015).).

Normality Detection

Jarque-Bera probability values is 0.150 which means it is greater than real level 5% (0.05) then you can it is concluded that the residuals are distributed normal (Sismar, A., Syah, S. R., & Sudirman, S. (2023)).

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Correlation Test
Based on comparison between the calculated r-values of more than 0.6804 The size of the r-table is 0.33 with real level of 0.05 (α=5%). Results shows that the Agglomeration variable (AG) influential processing industry positive and significant to the variable production output (Y) (Suyanto. (2012).

Production Efficiency
Measurement of production efficiency industry is divided into technical efficiency, price efficiency, economic efficiency and return to scale can be explained in Table 3.

Table 3. Production Efficiency Estimation Results (SFA)

No	Variabel	Koefisien	T-Ratio
1	**Konstanta**	0.11	0.277
2	X_1	0.17	0.188
3	X_2	0.87	0.323
4	X_3	0.14	0.311
5	X_4	0.32	0.678
6	**Efisiensi Teknis**	0.95	
7	**Inefisiensi**	0.05	
8	**Efisiensi Harga**	0.38	
9	**Efisiensi Ekonomi**	0.35	
10	***Return to scale***	1.61	
11	**N**	210	

Source: Frontier 4.1, 2018 (processed)

Technical Efficiency (ET)
Average technical efficiency of districts in Central Java province from 2010-2015, namely 0.95.

Price Efficiency (EH)
From all input calculations production factors Marginal Production Value (NPM) is as follows:

$$EH = \frac{NPMX1+NPMX2+NPMX3+NPMX4}{4}$$

$$EH = \frac{0.20 + 0.90 + 0 + 0.40}{4} = 0.38$$

Economic Efficiency (EE)
Calculation of economic efficiency can be achieved if technical efficiency and Price efficiency has been known to be possible calculated as follows:

EE = ET x EH
EE = 0.94 x 0.38 = 0.35

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Return To Scale (RTS)
The result of adding all the coefficients production variables can be obtained values return to scale of 1.61 is greater from 1 then the scale of industrial production processing experiences increasing conditions returns to scale (Romdhoni, A.H. (2015).

DISCUSSION

Interpretation of Measurement Results Based on the results of function regression production in table 1 shows variable coefficients have an influence positive and significant to output processing industrial production. Efficiency estimation results table 3 each variable proportionally can analyze the factors of production so as to maximize levels efficiency in the use of each each influencing variable processing industry production output.

Use of Production Capital (K) Against Industrial Production Output Processing and Production Efficiency
Based on Table 1 regression results the t-count value of 5.25 is greater than t-table is 1.6523 and the probability value of 0.0000 is smaller than the value of 0.05 ($\alpha = 5\%$) so it has a positive influence and significant to production output processing industry. Production efficiency in table 3 The production capital regression coefficient is obtained (X1) is 0.17. This shows that increased use of capital production can provide opportunities to the processing industry for increase production as it increases many production results then processes production will get bigger.

Use of Production Raw Materials (B) Against Industrial Production Output Processing and Production Efficiency
Based on Table 1 regression results the t-count value of 24.45 is greater than t-table is 1.6523 and the probability value of 0.0000 is smaller than the value of 0.05 ($\alpha = 5\%$) so it has a positive influence and significant to production output processing industry. Production efficiency in Table 3 raw material regression coefficient is obtained production (X2) is 0.87. This matter shows if there is an increase use of raw materials for industrial production there will be improvements in the process processing industrial production.

The Use of Production Labor (L) on Manufacturing Production Output and Production Efficiency
Based on Table 1, the regression result indicates a t-value of 6.18, which is greater than the t-table value of 1.6523, and the probability value is 0.0000, smaller than 0.05 ($\alpha = 5\%$), suggesting a positive and significant impact on manufacturing production output.

Efficiency of production in Table 3 shows a regression coefficient for labor (X3) of 0.14. This indicates that an increase in labor during the production process will lead to an increase in manufacturing production output.

The Use of Wage per Production Labor (U) on Manufacturing Production Output and Production Efficiency

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According to Table 1, the regression result shows a t-value of 13.53, greater than the t-table value of 1.6523, with a probability value of 0.0000, smaller than 0.05 ($\alpha = 5\%$), indicating a positive and significant impact on manufacturing production output.

Efficiency of production in Table 3 reveals a regression coefficient for wage per production labor (X4) of 0.35. This implies that an increase in wage per production labor will result in an increase in manufacturing production.

Technical Efficiency
Based on Table 3, it is evident that the use of production factors in manufacturing is not technically efficient, necessitating the addition of other production inputs to achieve a technical efficiency level of 1 (one).

Price Efficiency
Table 3 shows that the use of production factors in manufacturing is not price efficient as the price efficiency level is less than 1 (one). Therefore, adding production inputs is necessary to achieve price efficiency and maximize benefits in the manufacturing production process.

Economic Efficiency
Table 3 indicates that the use of production factors in manufacturing is not economically efficient as it is less than 1 (one). Achieving technical and price efficiencies is necessary to achieve economic efficiency. Economic efficiency is achieved when production factors are optimally utilized in the manufacturing production process.

Return to Scale
Based on Table 3, in conditions of increasing return to scale, manufacturing production has the opportunity to increase output by adding production factors optimally.

4. Conclusion

Enhancing regional economic growth and ensuring equitable societal well-being are crucial for improving: a. manufacturing production output by using production factors more efficiently; b. adding production factors proportionally to achieve better output scale; c. investing in production processes for machine rejuvenation or advanced technological development to enhance production through innovation and improving human resource quality, both through short-term technical training and long-term formal education.

The regional economy is labor-intensive, hence prioritizing regional growth in industries that employ a large workforce is essential. Developing labor-intensive industries should be a long-term and sustainable endeavor since regions have a substantial and growing workforce. In addition to boosting regional economic growth, equitable development is also a government concern, emphasizing inter-regional cooperation to leverage each region's strengths and create economic value, particularly through the concentration of manufacturing industries or industrial agglomeration.

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