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Total Factor Productivity Analysis, Solow Residual Study with Growth Accounting Model in Surabaya City

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A B S T R A C T
Total Factor Productivity (TFP) represents the efficiency level of input utilization in generating output within a specific region, often reflecting the role of technological progress and innovation. This study analyzes the TFP of Surabaya City from 2011 to 2024 using the Growth Accounting Model based on the Solow Residual approach. The main variables considered are Gross Regional Domestic Product (GRDP), Labor Force (Employment), and Capital. The research adopts a descriptive-verificative method to calculate and estimate the TFP value for 2025 using trend analysis, which allows projection despite incomplete future data. The findings reveal that TFP growth in Surabaya tends to fluctuate and remain relatively low, indicating inefficiencies in combining labor and capital to generate optimal output. Interestingly, during the COVID-19 pandemic year of 2020, the city achieved a positive TFP value, suggesting that reduced input utilization improved production efficiency. These results highlight the importance of technological innovation, workforce quality, and effective policy intervention in improving regional productivity. The study emphasizes the need for the Surabaya City Government to enhance efficiency through strategic investment in technology, human capital, and policy support to sustain long-term economic growth and competitiveness.

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INTRODUCTION

Total Factor Productivity is a useful benchmark or measure for assessing the efficiency and productivity of an economy in a region or industry. Total Factor Productivity measures how well factors of production, such as labor, capital, and other resources, are used to produce output. Total Factor Productivity is generally used to analyze long-term economic growth. An increase in Total Factor Productivity indicates that a region's economy is becoming more efficient in using existing resources to generate output.

Robert Solow is an economist known for his Solow growth model, which introduced Total Factor Productivity as a method or way to measure the contribution of technological progress to economic growth. In the Solow growth model, Total Factor Productivity functions as a residual that explains output growth that cannot be directly attributed to the accumulation of capital and labor. Economic growth and development are dynamic processes. Despite its simplicity, the Solow growth model is a dynamic general equilibrium model. In 1957, Solow developed the most common "tool" in macroeconomics, namely Growth Accounting.

Growth accounting is a tool or method of analysis useful for measuring the contribution of various factors related to economic growth. Growth accounting can help understand output growth and is explained through changes in inputs such as labor and capital, and even other factors such as Total Factor Productivity. The components of growth accounting are output, which is the GDP generated by an economy. Then, input is divided into two components: labor used in production and capital, such as the investment value related to the production process. Finally, Total Factor Productivity, which measures the level of efficiency and productivity, encompassing innovation, technology, and operational efficiency.

Total Factor Productivity (TFP) is crucial for projecting a region's future economic prospects. It is considered a crucial indicator of economic growth. It is generally used to analyze long-term economic growth. An increase in TFP indicates that a region's economy is becoming more efficient in utilizing existing resources to generate output. TFP also reflects technological advances and innovations that can increase productivity. Furthermore, TFP values can serve as benchmarks between regions and sectors. TFP is influenced by various factors, including technological innovation, workforce quality, and economic policy.

Surabaya is a city with an economy dominated by trade, processing, and accommodation and food and beverage providers, the three largest contributors to the city's GRDP. This, of course, can boost employment and encourage investment. The city also has a relatively high per capita income compared to other regions in East Java. This demonstrates the high economic potential of Surabaya and is a key driver in efforts to increase its competitiveness. The role of the local government is also crucial in driving economic growth and investment. Surabaya has a variety of supporting infrastructure that continues to develop, accompanied by the availability of human resources whose education levels continue to increase. With supportive policies and availability, Surabaya is

considered a potential destination for investors capable of contributing to economic growth.

According to data from the BPS, Surabaya's economic growth consistently outperforms that of East Java and even Indonesia every year. In fact, during the COVID-19 pandemic, its economic decline was even greater than that of East Java and Indonesia. Therefore, the question arises: Does the TFP growth rate increase annually in line with economic growth?

LITERATURE REVIEW

Technological Advancement on Solow's Growth

In addition to the possibility of substitution between capital (K) and labor (L), this model also includes an additional element of technological progress. Technological progress in the Solow model serves as a residual to explain long-term economic growth. Economic growth is directly related to increases in productivity levels. Furthermore, productivity levels are greatly influenced by the rate of technological change. Economic growth is directly related to increases in productivity levels. Furthermore, productivity levels are greatly influenced by the rate of technological change.

There is previous research that has explained the growth of TFP in a region, namely "KAJIAN TOTAL FACTOR PRODUCTIVITY MALAYSIA" By Candra Mustika, 2014. The results of the study show that the value of Malaysia's TFP growth for the period 1990 to 2008 is TFP growth remains low and fluctuates at a relatively low rate, hovering at no more than 2%. Malaysia's TFP growth during the period from 1990 to 2008 saw a slow increase in the early 1990s, peaking in 1991until the highest score in 2004, and then declining again in 2005. This gives rise to the following hypothesis from this study:

H1: It is estimated that the Total Factor Productivity of Surabaya City has increased every year.

Solow-Swan Growth Theory

Neoclassical growth theory was developed by Robert M. Solow of MIT in 1970 and Trevor W. Swan of the Australian National University in 1956. The Solow growth model is an extension of the Harrod-Domar model by adding labor as a second element. Furthermore, the Solow model introduces a third independent variable, technology, into the economic growth equation. The Solow-Swan model allows for the possibility of substitution between capital (K) and labor (L) inputs.

H2: It is estimated that in 2025 the Total Factor Productivity value of Surabaya City will increase.

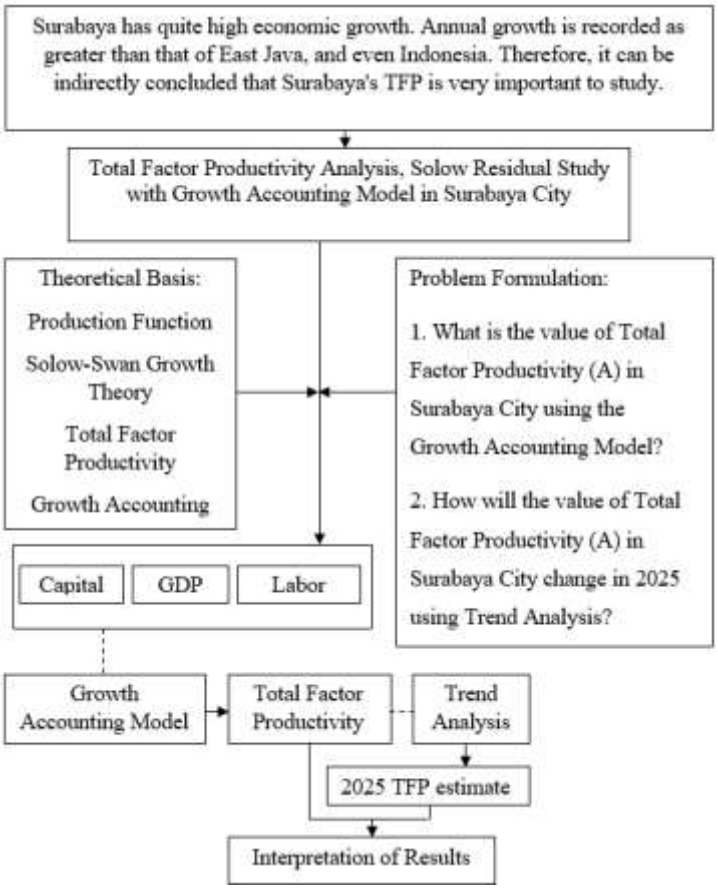

Figure 1. Conceptual Framework

METHODOLOGY

The purpose of this study is to calculate the Total Factor Productivity value in the city of Surabaya. This study uses a descriptive-verification approach. This approach aims to test tentative answers to questions, also known as hypotheses.

This research was conducted in Surabaya, and covered the period from 2010 to 2024. The Growth Accounting Model was used to calculate TFP growth and a rough estimate of the TFP value for 2025 was used using trend analysis.

Trend analysis is a method for estimating a future value based on the pattern of figures from several previous years. This method is used because calculating the TFP value requires three things: GRDP, Labor, and Capital. While the data for calculating the 2025 TFP, namely data on these three components, is not yet available, the trend analysis method is used to estimate the TFP value of Surabaya City in 2025. Considering that the figure is only an estimate that has not yet been realized, the government's role is still needed to realize this value through its policies.

The Growth Accounting Model is a calculation that aims to calculate Total Factor Productivity using a combination of three factors: GRDP, Labor, and Capital. This method uses the Cobb Douglass production function, where GRDP is Y, Labor is L, and Capital is K. The results of this calculation are expressed in percentage units. Using this method, a region can determine how efficient the combined value of these three components is. The higher the TFP value, the more efficient it is. This method measures the level of efficiency of the use of input

components, namely capital and labor, towards the resulting output, namely GRDP, in a region.

RESEARCH RESULT

To estimate the TFP growth value, growth data is required for each variable used, namely GRDP, Labor, and Capital, each year.

Table 1. Annual Variable Growth Data

Year	Growth		
	GDP	Capital	Labor
2011	7,1%	6,3%	-4,7%
2012	7,4%	8,7%	-5,7%
2013	7,6%	5,3%	11,2%
2014	7,0%	4,2%	-6,0%
2015	6,0%	5,1%	-1,4%
2016	6,0%	6,5%	1,0%
2017	6,1%	6,5%	2,0%
2018	6,2%	6,4%	3,4%
2019	6,1%	5,0%	3,1%
2020	-4,9%	-7,5%	-4,8%
2021	4,3%	1,1%	-0,5%
2022	6,5%	7,6%	6,9%
2023	5,7%	3,9%	-3,6%
2024	5,8%	6,2%	5,6%

Then the way to calculate TFP growth is to use the following formula:

$$\frac{dA}{A} = \frac{dY}{Y} - \alpha\frac{dK}{K} - (1-\alpha)\frac{dL}{L} \quad \text{..... (1)}$$

Where A is TFP, Y is output or GRDP, K is capital, L is labor, α is the elasticity of output to capital, and 1-α is the elasticity of output to labor. In this way, the TFP Growth calculation can be carried out and produces the TFP Growth value each year as follows.

Table 2. TFP Growth

Year	Growth			TFP Growth %
	GDP	Capital	Labor	
2011	0,071	0,063	-0,047	-6,9%
2012	0,074	0,087	-0,057	-7,2%
2013	0,076	0,053	0,112	-7,8%
2014	0,070	0,042	-0,060	-6,8%
2015	0,060	0,051	-0,014	-5,8%
2016	0,060	0,065	0,010	-5,9%
2017	0,061	0,065	0,020	-6,0%
2018	0,062	0,064	0,034	-6,0%
2019	0,061	0,050	0,031	-6,0%
2020	-0,049	-0,075	-0,048	4,7%
2021	0,043	0,011	-0,005	-4,2%
2022	0,065	0,076	0,069	-6,3%
2023	0,057	0,039	-0,036	-4,9%
2024	0,058	0,062	0,056	-5,6%

And because the results of the TFP growth calculation have been answered, then an estimate of TFP growth can be made using trend analysis in the following way:

$$\mathbf{Y = a + bX} \text{ or also } \mathbf{2025} = \frac{\sum Y}{n} + \frac{\sum XY}{\sum x^2}\mathbf{X} \quad \text{..... (2)}$$

Where Y is Data, a is the total of all Y divided by n, b is the sum of XY divided by Total X^2, and X is Time Encoding. By using this formula, the TFP growth estimate for 2025 can be obtained as follows:

Table 3. TFP Growth Estimation

	Year	TFP Growth (Y)	X	X Y	x^2
1	2011	-0,069	-7	0,5	49
2	2012	-0,072	-6	0,4	36
3	2013	-0,078	-5	0,4	25
4	2014	-0,068	-4	0,3	16
5	2015	-0,058	-3	0,2	9
6	2016	-0,059	-2	0,1	4
7	2017	-0,06	-1	0,1	1
8	2018	-0,06	1	-0,1	1
9	2019	-0,06	2	-0,1	4
10	2020	0,047	3	0,1	9
11	2021	-0,042	4	-0,2	16
12	2022	-0,063	5	-0,3	25
13	2023	-0,049	6	-0,3	36
14	2024	-0,056	7	-0,4	49
	Total	**-0,747**		**0,7**	**280**
	2025	-0,035 (-3,5%)			

DISCUSSION

The results of the Total Factor Productivity Growth calculation for 2011 to 2024 indicate that the TFPG value of Surabaya City tends to be low. However, each year's value has an increase and decrease that tends to be unstable. This contradicts the prediction in hypothesis 1. There was only one year that showed a positive TFPG value, namely 2020. In fact, that year was a year in which economic conditions were in decline due to the Covid-19 pandemic. Due to the decline in the percentage of GRDP, PMTB, and Labor growth in that year compared to the previous year, the TFPG value actually made it good or could be said to be efficient in its use to produce output. However, efficiency depends on technology and the level of efficiency is described by the TFP value (Eskani, 2018).

The relatively low TFPG (Finance Factor Reduction) figure in Surabaya City may indicate inefficiencies in processing inputs, such as capital and labor, to produce output. This may be due to an excessive labor force, or a disproportionate amount of capital compared to the output, namely GRDP. This is also related to the government's efforts to address unemployment in Surabaya. Due to Surabaya's large population, numerous job opportunities are needed to address the unemployment problem. This is evident in the numerous business sectors in Surabaya, capable of absorbing a significant workforce. Unfortunately, the large number of workers is not proportional to the resulting output, namely GRDP, resulting in a low Total Factor Productivity (TPF) value, which is considered inefficient in producing output.

The estimated TFPG value in 2025 using trend analysis assumes an increase from 2024, in accordance with hypothesis 2. Considering that this value is only

an assumption estimated using trend analysis because the data to calculate the TFPG in 2025 is not yet available, it does not rule out the possibility that this figure can be realized. Of course, this depends on the policy of the Surabaya City government to increase the TFPG value as an efficiency of managing the number of labor and capital against the results of input. Total Factor Productivity is related to economic growth, this is because several factors that are considered capable of influencing economic growth are also included in the main components of the TFPG calculation, such as human resources, capital accumulation, and technological progress (Marcal, 2024).

CONCLUSIONS AND RECOMMENDATIONS

The results of the calculation of the Total Factor Productivity Growth of Surabaya City show that the TFPG value of Surabaya City for the period 2011 to 2024 tends to experience instability such as increases and decreases every year. Meanwhile, the results of the estimated TFPG value for Surabaya City in 2025 show that there is an increase in the TFPG value from 2024 by -5.6% to -3.5%.

Meanwhile, suggestions for the Surabaya City government, the results of the study show that the TFPG value tends to be negative every year, while it is actually positive in the year affected by the pandemic due to the reduction in input sources such as labor and capital to produce output, namely GRDP, which indicates that there is a need for input reduction to produce that output or also additional output with that input. The relatively low TFPG figure in Surabaya City may indicate inefficiencies in processing inputs, such as capital and labor, to produce output, such as excessive labor or capital disproportionate to output, namely GRDP.

While this figure is merely an assumption estimated using trend analysis, and data for calculating the 2025 TFPG is not yet available, it is still possible that this figure could be realized. This, of course, depends on the Surabaya City Government's policy of increasing the TFPG value as a result of the efficient management of labor and capital compared to input results.

Surabaya's GDP data has increased every year. However, this is not in line with its TFP value, which tends to fluctuate in a low position, which can be concluded as having a low level of efficiency in processing several existing inputs, namely labor and capital, to become output, namely GDP in Surabaya. Therefore, the role of the Surabaya city government is very much needed to use existing inputs to create greater output, thus being depicted with a high level of efficiency.

ADVANCED RESEARCH

For researchers who will examine the TFPG value using the Growth Accounting Model in a region, ensure that the data for the three variables, namely GRDP, Capital, and Labor in the region and the desired year to be studied are available and accurate.

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