Analysis of Productivity Measurement Using The American Productivity Center (APC) Method (Case Study PG Tjoekir Jombang, East Java)

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Abstract

Tjoekir Sugar Factory is one of the sugar factories located in Jombang Regency. As a producer of one of the 9 basic commodities, its resources need to always be managed so that they remain in optimal condition. This research aims to determine the level of company productivity, identify the factors that influence it, and determine efforts to improve it. The data used in the research are raw material input (amount of sugar cane, lime, phosphate, sulfur, flocculant), labor input, energy input, machine depreciation input, and the output produced (sugar, molasses, filter cake). To measure the productivity index, profitability index, and price improvement index, the American Productivity Center (APC) method is used and analyzed using fishbone diagrams. The calculation results from 2015 - 2019 show a decrease in the productivity index compared to the base period. The total productivity decline rates starting in 2016, 2017, 2018, and 2019 were 98.90% (highest), 93.35% (lowest), 94.18% and 95.32, respectively. The average profitability index tends to increase, the highest total was in 2018 at 115.33%, while the lowest was in 2016 at 106.03%. The highest Price Improvement Index value was in 2018 at 1.22%, the lowest value was in 2016 at 1.09%. The decline in productivity is caused by several factors such as raw materials, labor, and machines. Increasing productivity can be achieved by improving the quality of incoming sugarcane raw materials through testing sugarcane quality, optimizing employee performance monitoring, and scheduling regular machine maintenance

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INTRODUCTION

Productivity is a measure of how efficient a production system is in producing products by comparing output and input. Productivity is one of the

important things in the company to monitor company performance, as a means to analyze and encourage the company's production efficiency. According to Hartanto (2013), productivity is a comparison between output and input. Productivity is an indicator to find out how well a company utilizes its resources

In the calculation of productivity, there are two types, namely total productivity (Total Factor Productivity) and partial productivity (Partial Productivity). Total productivity is the ratio of output to input as a whole. Measuring the change in total productivity over some time sums all factors related to the quantity of output and inputs used during the period. Related factors include people, machines, energy, maintenance, and depreciation of machinery, materials, and others. Partial productivity is a comparison of output with one type of time union input, such as raw material costs or labor wages (Herjanto 2016)

The rapid development of industry, especially the sugar industry, requires goodand optimal resources in its utilization. Sugar production that has not been able to reach the target is caused by various obstacles both off-farm and on-farm. So witha situation like this, it is necessary to measure the level of productivity of the Tjoekir Sugar factory, and the level of efficiency of the company in utilizing the use of its resources.

The method used in this study is the APC method. The APC (The American Productivity Center) method is a method that measures the comparison of data in the base period with current data as a measurement of productivity. Comparison between outputs and inputs is used to know how efficient productivity is and how the level of profitability is achieved by the company. The advantages of the APC method can cover the shortcomings of the OMAX method which only calculates thelevel of productivity (Okafor, 2013).

This study aims to determine the productivity that has been achieved by Tjoekir Sugar Factory based on measurements, identify factors that influence changes in productivity, and provide suggestions for improvements to increase productivity in sugar factories in sugar production.

RESEARCH METHODS

The research was conducted from October to December 2019 at the Tjoekir Sugar Factory, Jombang, East Java. The data collection technique used in this study is an interview, which is a collection of information by conducting questions and answers with parties who can provide clear information and explanations related to the problems of matters in the research. Documentation, collecting data by looking at documents related to research.
The data analysis technique used is to use the APC (American Productivity Center) method. The limitation of the problem in this study is the measurement of productivity in the period 2015-2019 and 2015 as the base year. The inputs used in measurement are raw material inputs, labor inputs, energy inputs, and machine depreciation expressed in rupiah. The output used is the production in the form of sugarcane, tete, and compost.

AMERICAN PRODUCTIVITY CENTER (APC) METHOD

Productivity measurement using the APC method can produce three productivity measurements, namely productivity index measurement, profitability index, and price improvement index. In measuring productivity using the APC model, there is a relationship that affects each other between profitability productivity and price

improvement. Profitability can increase through increased productivity and improved product prices (Fithri and Regina, 2015).

The American Productivity Center's method as a whole considers business processes, both transformational, physical, and financial. The productivity ratio determines the extent of the company's efficiency in utilizing the use of resources (inputs) to produce output (Deoranto et al., 2016; Gupta and Dey, 2012).

According to Summanth (1998), the steps used to calculate productivity using the APC method are:
1. Calculating the productivity index figure
   The APC model in calculating the productivity index is carried out using the constant price level. The formula for calculating the output and input indices is as follows:
   Output index=O_n/O_i (1)
   Material Input Index=M_n/M_i (2)
   Labor Input Index =L_n/L_i (3)
   Energy Input Index=E_n/E_i (4)
   Machine depreciation index=D_n/D_i (5)
   Total Input Index=I_n/I_i (6)
   Keterangan:
   O = Output (Rupiah)
   M = Material Input (Rupiah)L = Labor Input (Rupiah)
   E = Energy Input (Rupiah)
   D = Machine Depreciation Input (Rupiah)I = Total Input (Rupiah)
   n = Measured periodi = Base period

   The step to measure the main productivity index is done by calculating the ratio ofthe output index to the input index formulated as in the equation:
   IPM=(Output Index)/(Material Input Index) ×100   (7)
   IPL=(Output Index)/(Labor Index) ×100   (8)
   IPE=(Output Index)/(Energy Input Index) ×100   (9)
   IPD=(Output Index)/(Depreciation Input Index) ×100   (10)
   IPF=(Output Index)/(Total Input Index) ×100   (11)

2. Calculating the Profitability Index
   The steps taken to calculate the profitability index using prices apply with the following formula:
   IPFM=(Indeks Output)/(Indeks Input Material) ×100   (12)
   IPFL=(Indeks Output)/(Indeks In Tenaga Kerja) ×100   (13)
   IPFE=(Indeks Output)/(Indeks Input Energi) ×100   (14)
   IPFD=(Indeks Output)/(Indeks In Depresiasi) ×100   (15)
   IPFI=(Indeks Output)/(Indeks Input Total) ×100   (16)

3. Calculating the Price Improvement Index
   IPH=(Indeks Profitabilitas)/(Indeks Produktivitas)   (17)

RESULTS AND DISCUSSION
Productivity Index

Tabel 1. Tjoekir Sugar Factory Productivity Index for the 2015-2019 Period

Deskripsi	Indeks Produktivitas				
	2015[a]	2016	2017	2018	2019
Bahan Baku	100	85,58	97,63	98,37	99,53
Tenaga Kerja	100	116,83	87,81	86,62	89,63
Energi	100	106,51	115,76	117,30	123,68
Penyusutan	100	116,32	86,72	88,30	88,18
Total	100	98,90	93,35	94,18	95,32

Source: Primary Data Processed (2019)

a) Basic Year

The productivity index of raw materials of the Tjoekir Sugar Factory during the period 2015-2019 is based on Table 1. It is known that the average tends to decrease. The highest raw material productivity index was in 2019 at 99.53% while the lowest in 2016 was 85.58%. This is due to the factor of raw materials that do not meet the standard criteria of MBS (Sweet, Clean, and Fresh). According to Farida (2015), to ensure industrial activities run smoothly, one of them requires good raw materials. Raw materials have a great influence on productivity.

The labor productivity index had the highest productivity index value in 2016 of 116.83% and the lowest value in 2018 of 87.81%. The average labor productivity index at the Tjoekir Sugar Factory has decreased due to undisciplined and unprofessional work. In addition, this is influenced by age, education level, and work experience. To achieve average work productivity, companies need to analyze the needs and use of labor to achieve efficiency in the use of labor (Hariastuti, 2013).

The energy productivity index at the Tjoekir Sugar Factory was the highest in 2019 at 123.68% and the lowest in 2016 at 106.51%. The average energy productivity index of PG Tjoekir Jombang has increased. This is because the company can save the use of electrical energy and dregs fuel efficiently. According to Liong (2010), Strategies for controlling expenditure and increasing productivity can be done by saving energy use.

The average depreciation productivity index at the Tjoekir Sugar Factory has decreased. Decreased machine depreciation productivity tends to be caused by the waste of machine use caused by the aging age of the machine. The largest index value was in 2016 at 116.32% and the lowest in 2019 at 88.18%. According to Saiful et al. (2014) low machine productivity due to engine damage. In addition, low machine productivity is caused by the age of the machine and old components.

Where the economic life of the machine has run out and affects the level of reliability of the machine's work. Economic life is the age of an asset that ends until the use of the asset is no longer economically profitable. But technically the asset can still be used (Parinduri et al. 2018).

Based on Table 1. It can be seen that the total productivity index of PG Tjoekir Jombang has decreased on average. The highest total productivity index value was in 2016 at 98.90% and the lowest total productivity value was in 2017 at 93.35%. The productivity index graph can be seen in Figure 1.

Profitability Index

The raw material profitability index at the Tjoekir Sugar Factory was the highest in 2018 at 122.37% and the lowest value in 2016 at 96.04%.
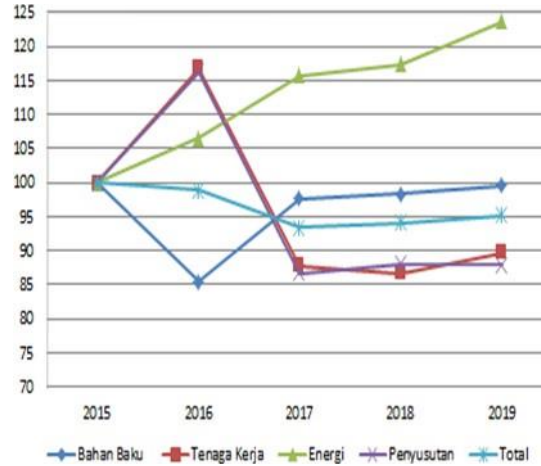

Figure 1. Tjoekir Sugar Factory Productivity Index Graph (2015-2019)Source: Diola Primary Data (2019)

The factor causing the decline in the raw material profitability index was due to the increasing price of raw materials so the costs incurred for raw materials were even greater, amounting to Rp. 35,959,623,162 compared to the base year of Rp. 26,960,895.39.

The highest labor profitability index in 2016 was 121.5% while the lowest in 2017 was 97.19%. The decrease in labor profitability is caused by the cost or wages of labor increasing while the output of production is low. According to Blocher et al., (2007), and Daghani et al., (2012) several factors cause the increase in the cost of raw materials and labor such as an increase in the number of units produced and sold, changes in the proportion of inputs used, and an increase in the cost of resources used.

Tabel 2. Indeks Profitabilitas Pabrik Gula Tjoekir Periode Tahun 2015-2019

Deskripsi	Indeks Profitabilitas				
	2015[a]	2016	2017	2018	2019
Bahan Baku	100	96,04	114,67	122,37	106,42
Tenaga Kerja	100	121,53	97,19	98,57	101,67
Energi	100	98,44	140,34	152,16	160,00
Penyusutan	100	127,70	103,67	108,10	112,43
Total	100	108,03	109,67	115,33	110,22

Source: Primary Data Processed (2019)

a) BasicYear

The highest energy profitability index in 2019 was 160.00% and the lowest value in 2016 was 98.44%. The decline in profitability occurred due to increased energy use and an increased basic electricity tariff of Rp. 1300 in 2016 which was not accompanied by electricity efficiency. According to Nugroho and Triwilswandio

(2012), the Basic Electricity Tariff is the basic tariff value applied by PLN in calculating the cost of electricity usage unity Kwh. The amount of electricity energy costs will increase along with the increase in TDL (Basic Electricity Tariff) which affects the increase in production costs.

The highest depreciation profitability index in 2016 was 127.70% and the lowest index value in 2017 was 103.67%. One of the causes of low profitability is due to the factor of the engine getting older so that engine performance decreases and engine maintenance costs are getting bigger. So the company needs to carry out maintenance and repair of machines on an ongoing basis. The profitability index chart can be seen in Figure 2.
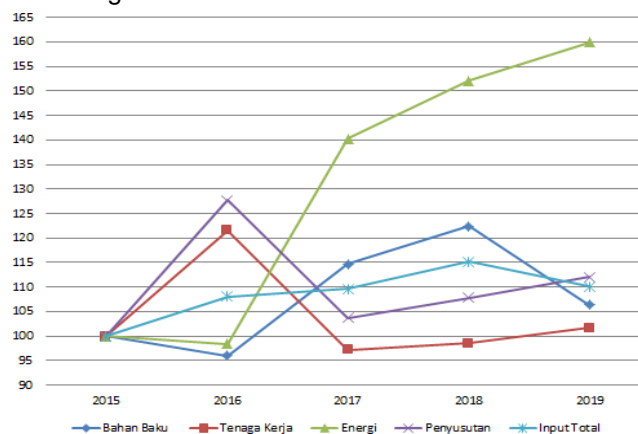

Figure 2. Tjoekir Sugar Factory Profitability Index Chart (2015-2019)
Source: Primary Data Processed (2019)

Based on Table 2. It is known that the calculation of the average total profitability index tends to increase. The highest total profitability index was in the 2015-2018 period of 115.33%, an increase of 15.33%, and the lowest profitability index in the 2015-2016 period of 108.04%, an increase of 8.04%.

Indeks Perbaikan Harga

Table 3. Tjoekir Sugar Factory Price Improvement Index 2015-2019

Deskripsi	Indeks Perbaikan Harga				
	2015[a]	2016	2017	2018	2019
Bahan Baku	1,00	1,12	1,17	1,24	1,07
Tenaga Kerja	1,00	1,04	1,11	1,14	1,13
Energi	1,00	0,92	1,21	1,30	1,29
Penyusutan	1,00	1,10	1,20	1,22	1,28
Total	1,00	1,09	1,17	1,22	1,16

Source: Primary Data Processed (2019)
[a] BasicYear

Based on Table 3. The Price Improvement Index shows the average index value that tends to increase. The highest price improvement index was in 2018 at 1.22% and the lowest in 2016 at 1.09%. The increase in the price improvement index is due to the productivity index which tends to decrease but the profitability index

tends to increase. Where the average profitability index from 2015 to 2019 the index increased by 108.03%, 109.67%, 115.33%, and 110.22%. While the total productivity index from 2015-2019 on average tends to decline, namely in 2016, 2017, 2018, and 2019 decreasing to 98.90%, 93.35%, 94.18%, and 95.32%. Productivity has decreased due to raw materials produced, unproductive labor, waste of energy use, and machine work that is not optimal. The work of the machine decreases due to the age of the engine getting older. So it requires optimal maintenance costs to maintain the quality of the machine. The price improvement index chart can be seen in Figure 3.
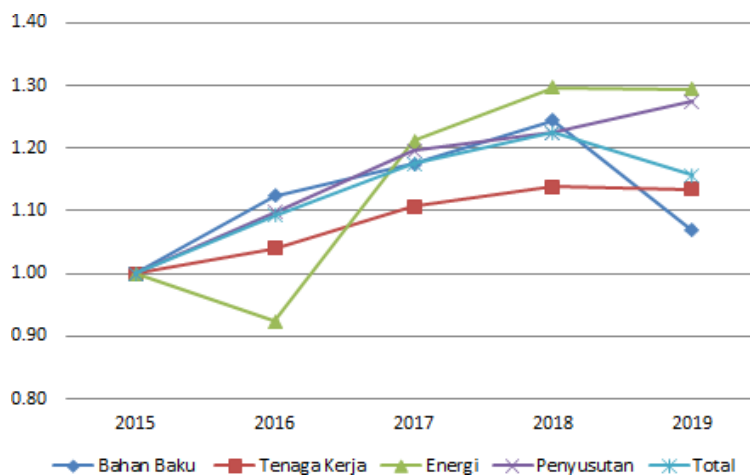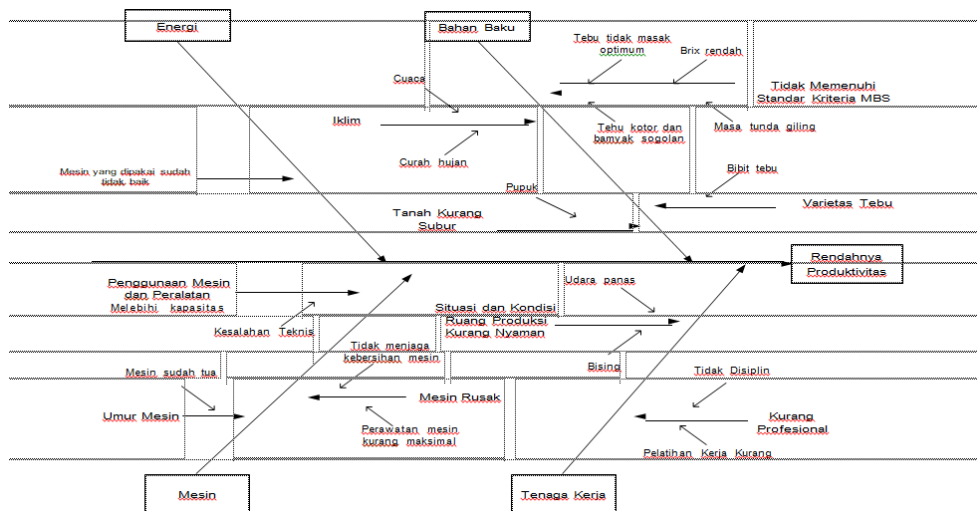

Figure 3. Tjoekir Sugar Factory Price Improvement Index Chart (2015-2019).
Source: Primary Data Processed (2019)

Productivity Evaluation

Productivity measurement depends on the output and input used, if there is a change between output and input then the level of productivity will change. Productivity evaluation was conducted to identify factors that caused the low productivity of Tjoekir Sugar Factory during measurement. According to Kulsum (2017) to increase company productivity PT. XYZ in later periods can be by using a causal diagram or fishbone. Analysis of the decline in Tjoekir Sugar Factory productivity. Tjoekir is done using a fishbone diagram as shown in Figure 4.

Energi — Bahan Baku — Tebu tidak masak optimum — Brix rendah

Cuaca

Tidak Memenuhi Standar Kriteria MBS

Iklim — Tebu kotor dan banyak sogolan — Masa tunda giling

Mesin yang dipakai sudah tidak baik — Curah hujan — Bibit tebu

Pupuk — Varietas Tebu

Tanah Kurang Subur

Rendahnya Produktivitas

Penggunaan Mesin dan Peralatan Melebihi kapasitas — Udara panas

Situasi dan Kondisi Ruang Produksi Kurang Nyaman

Kesalahan Teknis

Tidak menjaga kebersihan mesin — Bising — Tidak Disiplin

Mesin sudah tua — Mesin Rusak — Kurang Profesional

Umur Mesin — Perawatan mesin kurang maksimal — Pelatihan Kerja Kurang

Mesin — Tenaga Kerja

Productivity Improvement Efforts

Based on the analysis of productivity and profitability calculations, it is known that until now the productivity obtained is low but the profitability is high so the price improvement index is good. So if productivity is increased, it is expected that profitability will be higher so that the price improvement index will be better. The results of the productivity evaluation show the factors that influence the decline in productivity as shown in Figure 4.8. Based on these factors, plans are carried out to increase productivity at the Tjoekir Sugar Factory, namely:

1. **Increased Raw Material Productivity**

   To increase the productivity of raw materials, the Tjoekir Sugar Factory must be more careful in managing and controlling incoming sugarcane raw materials. Where milled sugarcane must meet the criteria of MBS (Sweet, Clean, and Fresh). Sweet sugarcane is sugarcane that has an optimum maturity factor and is ready to cut, has sufficient sugar content or yield, and has a minimum brix of 18. So the company needs to check the brix first before logging sugarcane to improve the control of sugarcane to be produced. In addition, sugarcane raw materials that enter sugarcane emplacements are checked brix and pH to anticipate that the incoming sugarcane is following predetermined standards.
   Clean sugarcane is sugarcane that is free from stirs, sogolan, shoots, and other impurities that can affect the production process. Fresh Sugarcane is the time it takes for sugarcane from cutting, entering the mill to grinding must be as fast as possible, because the longer the milling delay time, the sugar content in the sugarcane will decrease. The delay period of sugarcane from the plantation to the sugarcane mill is approximately 2x24 hours. Milling sugarcane raw materials using the FIFO system aims to maximize milling.

2. **Increased Labor Productivity**

   Low labor productivity can be overcome by giving warnings in the form of light sanctions, moderate sanctions, and severe sanctions to minimize violations committed by workers. Leaders must also always motivate company employees. Companies can provide bonuses or compensation for the success of employees who have achieved good work performance. In addition, companies need to hold regular meetings to hold work evaluations and continuous training to improveemployee performance. This is so that employees

can carry out their work properly and responsibly so that the company's operational activities can run smoothly.

According to Hakim (2010), in achieving work productivity, one of them is byproviding work motivation as a form of coaching to company employees. This motivation is expected to be used as a guideline to increase labor productivity which can be done continuously and sustainably. Efforts to overcome uncomfortable production space caused by hot air can be made by adding an Exhaust fan, Turbine ventilator, and Exhaust. This is because the Exhaust fan and Turbine Ventilator remove hot air in the room and the exhaust function provides fresh air into the room (Yulianti, 2016). In addition, noise control in factories can be done by technical means (engineering control), the use of ear protection equipment (APT) properly and correctly for workers, and the implementation of counseling programs on occupational safety and health.

3. Increased Energy Productivity

During the measurement of energy, productivity is in good condition. The company can optimize the efficiency of energy use. Labor awareness of energy use is a priority in operating, so there needs to be an important role of leadership in controlling the workforce to increase labor awareness of saving energy use so that production can be more optimal.

4. Increased Machine Productivity

Machine productivity can be increased by carrying out scheduled and periodic machine maintenance. This is done to minimize the occurrence of damage to production machines. The company must also have technicians who have guaranteed abilities in machine maintenance. According to Dolphina (2011), Production machinery and equipment in good condition can increase efficiency and productivity. The machine is used continuously, and the level of machine readiness decreases. So that in maintaining the level of machine readiness and using machines so that the continuity of production can be guaranteed, it requires a maintenance activity. According to Praharsi et al. (2015), machines are physical assets that require maintenance so that the company continues to be productive. Companies or industries need to carry out preventive maintenance to maintain the quality of the machine. Preventive Maintenance serves to prevent sudden machine damage, increase reliability, and reduce downtime. Through the use of good preventive maintenance, the company's losses when production can be reduced and expensive machine repair costs can be reduced.

CONCLUSION

Based on the results of the research that has been done, the conclusions obtained are as follows:

1. The total productivity index value at the Tjoekir Sugar Factory tends to decrease on average from the base period. In 2016, 2017, 2018, and 2019 it was 98.90%, 93.35%, 94.18% and 95.32%. The highest productivity growth was in 2017 amounting to 93.35% of the base period.

2. The cause of declining productivity at the Tjoekir Sugar Factory is caused by various factors such as raw materials, labor, and depreciation.

3. Increasing productivity can be done by improving the quality of incoming raw materials through sugarcane quality testing. Furthermore, optimization of employee performance supervision and scheduling of periodic machine

maintenance.

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