International Conference on Economics, Management, and Business (IC-EMBus)
VOL. 1, 2023 hlm. 444–454
https://journal.trunojoyo.ac.id/icembus

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

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INFO ARTICLE

Keywords:

APC, Fishbone, Input, Output, Productivity

Abstract

Tjoekir Sugar Factory is one of the sugar factories located in Jombang Regency. As a producer of one of the 9 staple commodities, its resources need to always be managed to remain in optimal condition. This research aims to determine the level of productivity of companies, identify the factors that affect it, and determine efforts to improve it. The data used in the study were raw material inputs (amount of sugarcane, lime, phosphate, sulfur, flocculants), labor inputs, energy inputs, machine shrinkage inputs, and output produced (sugar, molasses, filter cakes). To measure the productivity index, profitability index, and price increase index, the American Productivity Center (APC) method was used and analyzed using a fishbone diagram. The results of calculations from 2015 - 2019 show a decrease in the productivity index compared to the base period. The total rate of productivity decline that began in 2016, 2017, 2018, and 2019 was 98.90% (highest), 93.35% (lowest), 94.18% and 95.32%, respectively. The average profitability index tends to increase, the highest total in 2018 was 115.33%, while the lowest in 2016 was 106.03%. The highest Price Increase Index value in 2018 was 1.22%, the lowest value in 2016 was 1.09%. The decrease in productivity is caused by several factors such as raw materials, labor, and machinery. Increased productivity can be achieved by improving the quality of incoming sugarcane raw materials through sugarcane quality testing, optimizing employee performance monitoring, and scheduling regular machine maintenance

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E-ISSN: 3026-0965

DOI :

INTRODUCTION

Productivity is a measure of how efficient the production system is in producing products by comparing outputs and inputs. Productivity is one of the important things in the company to monitor the company's performance, employee performance is a stage of achievement as an employee's work achievement, this is certainly very important as a means to analyze and encourage the company's production efficiency. The company must guarantee quality for its sustainability. According to Hartanto (2013), productivity is a comparison between output and input. Productivity is an indicator to know how well a company makes use of its resources

In calculating 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 a period of time adds up all the factors related to the quantity of outputs and inputs used during the period. Related factors include people, machines, energy, maintenance, and shrinkage of machines, materials, and others. Partial productivity is the comparison of output with one type of time union input, such as the cost of raw materials or labor wages (Herjanto 2016)

The rapid development of the industry, especially the sugar industry, requires good and optimal resources in its utilization. Indonesia is a country that is rich in natural resources, human resources, and has land and seas that stretch geographically. Human resources are so far an important asset for organizations. Sugar production that has not been able to reach the target is caused by various obstacles both off-farm and on-farm. So with a situation like this, it is necessary to measure the productivity level of the Tjoekir Sugar factory, and the company's efficiency level in utilizing 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 measure of productivity. The comparison between output and input is used to find out how efficient productivity is and how the level of profitability is achieved by the company. The advantages of the APC method can make up for the shortcomings of the OMAX method which only calculates the level of productivity (Okafor, 2013). Therefore, technology affects the performance of organizations and businesses.

This study aims to find out the productivity that has been achieved by the Tjoekir Sugar Factory based on measurements, identify factors that affect productivity changes, and provide suggestions for improvement to increase the productivity of the sugar factory 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 interviews, 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 the things in the research. Documentation, collecting data by looking at documents related to research.
The data analysis technique used is using 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 the measurement are raw material inputs, labor inputs, energy inputs, and machine depreciation expressed in rupiah. The output used is production in the form of sugarcane, tete, and compost.

METODE AMERICAN PRODUCTIVITY CENTER (APC)

Productivity measurement using the APC method can produce three productivity measurements, namely productivity index measurement, profitability index, and price increase index. In measuring productivity using the APC model, there is a mutually influencing relationship between profitability productivity and price increases. Profitability can increase through increased productivity and increased 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 a 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. Calculate productivity index figures
   The APC model in calculating the productivity index is carried out using a constant price level. The formula for calculating the output and input indices is as follows:
   Output index=On/Oi (1)
   Indeks Input Material = Mn / Mi (2)
   Labor Input Index = Ln / Li (3)
   Energy Input Index=En/EI (4)
   Machine shrinkage index = Dn / Di (5)
   Total Indeks Input = In/II (6)
   Information:
   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 period i = Base period

   The step of measuring the main productivity index is carried out by calculating the ratio of the output index to the input index which is formulated as in the equation:
   IPM=(Output Index)/(Material Input Index) ×100 (7)
   IPL=(Output Index)/(Employment 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=(Output Index)/(Index in Employment) ×100 (13)
   IPFE=(Output Index)/(Energy Input Index) ×100 (14)

IPFD=(Output Index)/(Index In Depreciation) ×100 (15)
IPFI=(Indeks Output)/(Indeks Input Total) ×100 (16)

3. Calculating the Price Increase Index
IPH=(Profitability Index)/(Productivity Index) (17)

RESULTS AND DISCUSSION

Productivity Index

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

Description	Productivity Index				
	Year 2015	2016	2017	2018	2019
Raw Materials	100	85,58	97,63	98,37	99,53
Workforce	100	116,83	87,81	86,62	89,63
Energy	100	106,51	115,76	117,30	123,68
Depreciation	100	116,32	86,72	88,30	88,18
Entire	100	98,90	93,35	94,18	95,32

Source: Processed Primary Data (2019)

a) Foundation 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 productivity index of raw materials was the highest in 2019 at 99.53% while the lowest in 2016 was 85.58%. This is due to the raw material factor that does not meet the standard criteria of MBS (Sweet, Clean, and Fresh). According to Farida (2015), to ensure that industrial activities run smoothly, one of them requires good raw materials. Raw materials have a great influence on productivity.

The labor productivity index has 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, it 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 fuel residue efficiently. According to Liong (2010), the strategy of controlling expenditure and increasing productivity can be carried out by saving energy use.

The average depreciation productivity index at the Tjoekir Sugar Factory has decreased. The decrease in engine shrinkage productivity tends to be caused by wasteful use of machinery caused by the aging of the machine. The largest index value in 2016 was 116.32% and the lowest in

2019 was 88.18%. According to Saiful et al. (2014) low engine productivity due to engine failure. In addition, the low productivity of the machine is due to the age of the machine and old components.

Where the economic life of the machine has expired 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. However, 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 in 2016 was 98.90% and the lowest total productivity value in 2017 was 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 was 96.04%.

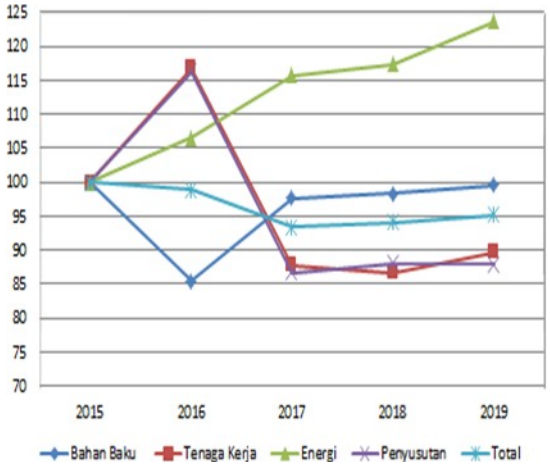


Figure 1. Tjoekir Sugar Mill Productivity Index Graph (2015-2019)
Source: Diola Primary Data (2019)

The factor causing the decline in the raw material profitability index was caused by the increase in raw material prices so that the cost incurred for raw materials was 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 decline in labor profitability is caused by an increase in labor costs or wages while production output is low. According to Blocher et al., (2007), and Daghani et al., (2012) several factors that cause an increase in the cost of raw materials and labor such as an increase in the number of units produced and sold, a change in the proportion of inputs used, and an increase in the cost of resources used.

Table 2. Tjoekir Sugar Mill Profitability Index for the Period of 2015-2019

Description	Profitability Index				
	Year 2015	2016	2017	2018	2019
Raw Materials	100	96,04	114,67	122,37	106,42
Workforce	100	121,53	97,19	98,57	101,67

Energy	100	98,44	140,34	152,16	160,00
Depreciation	100	127,70	103,67	108,10	112,43
Entire	100	108,03	109,67	115,33	110,22

Source: Processed Primary Data (2019)

a) Foundation Year

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 an increase in energy use and an increase in the 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 value of the basic tariff applied by PLN in calculating the cost of using electricity per Kwh. The amount of electrical 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 aging engine factor so that engine performance decreases and engine maintenance costs are increasing. So the company needs to carry out continuous maintenance and repair of the machine. The profitability index graph can be seen in Figure 2.

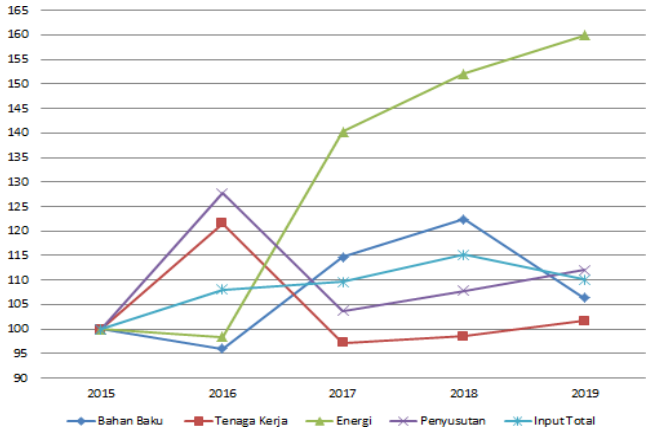


Figure 2. Tjoekir Sugar Mill Profitability Index Chart (2015-2019) Source: Primary Data Processed (2019)

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

Price Improvement Index

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

Description	Price Improvement Index				
	Year 2015	2016	2017	2018	2019
Raw Materials	1,00	1,12	1,17	1,24	1,07
Workforce	1,00	1,04	1,11	1,14	1,13
Energy	1,00	0,92	1,21	1,30	1,29

Depreciation	1,00	1,10	1,20	1,22	1,28
Entire	1,00	1,09	1,17	1,22	1,16

Source: Processed Primary Data (2019)
[a)] Foundation Year

Based on Table 3. The Price Increase 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 increase 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 increased by 108.03%, 109.67%, 115.33%, and 110.22%. Meanwhile, the total productivity index from 2015-2019 tends to decline on average, namely in 2016, 2017, 2018, and 2019 decreased to 98.90%, 93.35%, 94.18%, and 95.32%. Productivity has decreased due to raw materials produced, unproductive labor, wasted energy use, and suboptimal machine work. The work of the machine is reduced because the age of the machine is getting older. So it requires optimal maintenance costs to maintain the quality of the machine. A graph of the price increase index can be seen in Figure 3.

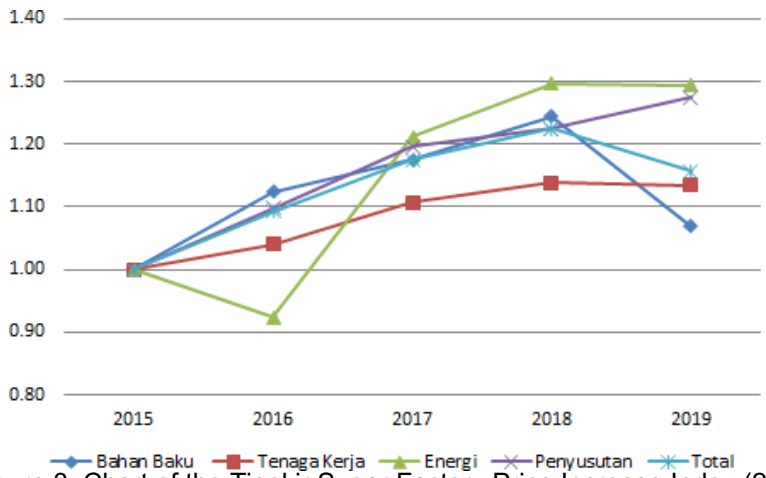
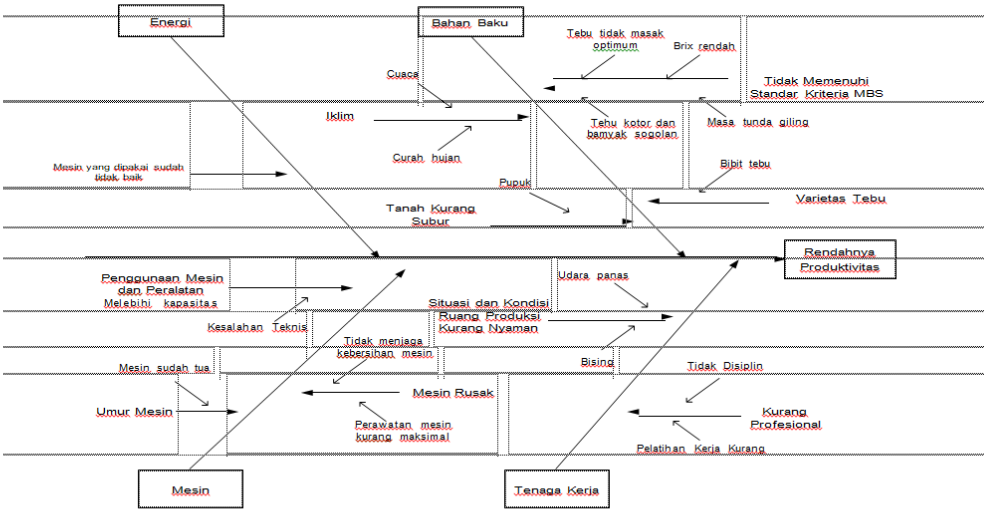


Figure 3. Chart of the Tjoekir Sugar Factory Price Increase Index (2015-2019).
Source: Processed Primary Data (2019)

Productivity Evaluation

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



Efforts to Increase Productivity

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 that the price increase index is good. So if productivity increases, it is expected that profitability will be higher so that the price increase index will be better. The results of the productivity evaluation show the factors that affect the decrease in productivity as shown in Figure 4.8. Based on these factors, a plan was made 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 optimal ripeness factor and is ready to be cut, has sufficient sugar content or yield, and has a brix of at least 18. So the company needs to check the brix first before cutting sugarcane to improve the control of the sugarcane to be produced. In addition, the raw materials of sugarcane that enter the sugarcane emplacement are checked for brix and pH to anticipate that the incoming sugarcane follows the standards that have been determined.

   Clean sugarcane is sugarcane that is free from mixes, sogolan, shoots, and other impurities that can affect the production process. Fresh Sugarcane is the time it takes for sugarcane from cutting, entering the factory 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 for sugarcane from plantations to sugarcane factories 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 providing warnings in the form of light sanctions, moderate sanctions, and heavy sanctions to minimize violations committed by workers. Leaders must also always motivate the company's 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 ongoing training to

improve employee 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 by providing 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 in a sustainable and sustainable manner. Efforts to overcome uncomfortable production rooms due to hot air can be done by adding exhaust fans, turbine ventilators, and exhaust. This is because the exhaust fan and Turbine Ventilator eliminate 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 carried out by technical means (engineering control), the use of ear protection equipment (APT) properly and correctly for workers, and the implementation of occupational safety and health counseling programs.

3. **Increased Energy Productivity**

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

4. **Increased Machine Productivity**

   Machine productivity can be increased by performing scheduled and periodic machine maintenance. This is done to minimize damage to production machines. The company must also have technicians who have guaranteed capabilities in machine maintenance. According to Dolphina (2011), production machines and equipment in good condition can increase efficiency and productivity. The machine is used continuously, and the readiness level of the machine decreases. So that in maintaining the level of machine readiness and using the machine so that the continuity of production can be guaranteed, maintenance activities are needed. According to Praharsi et al. (2015), machines are physical assets that need 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 works to prevent sudden machine breakdowns, improve reliability, and reduce downtime. Through the use of good preventive maintenance, the company's losses during production can be reduced and the cost of expensive machine repairs can be reduced.

CONCLUSION

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

1. The total value of the productivity index at the Tjoekir Sugar Factory tends to decrease on average from the base period. In 2016, 2017, 2018, and 2019, they were 98.90%, 93.35%, 94.18% and 95.32%. The highest productivity growth in 2017 was 93.35% from the base period.
2. The cause of the decrease in 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, optimizing employee performance supervision and scheduling regular machine maintenance.

REFERENCE

Blocher, EJ, Kung, HC, Gary, C and Thomas, W.L. 2007. Organizational Excellence: A Strategic Model Towards a World Class Quality Company. Jakarta: PT. Gramedia Pustaka Utama.

Daghani, R., Nasr, M., and Khanbeigi, MA 2012. Productivity, a New Paradigm for Management, Accountants and the Business Environment. *International Journal of Business and Management*. 6(6), 247-262.

Doeranto, P., A. Harwitasari, D. M. Ikasari. 2016. Analysis of Productivity and Profitability of Apple Cider Production with the American Productivity Center Method at KSU Brosem. *Journal of Agroindustry Technology and Management.* 5(3): 114-124.

Dolphina, E. 2011. Implementation of Maintenance and Reliability to Improve the Company's Quality and Competitiveness. *Dian Journal.* 11(3): 269-275

Farida, A. Y. 2015. Factors affecting the productivity of the Rambak cracker industry in Bangsal and Mojoanyar Districts, Mojokerto Regency. *Swara Bhumi*. 3(3): 256-263.

Faidal, F. 2020. The Study of Workplaceand Work Experiences on Employee Performance. International Journal of Advanced Science and Technology Vol. 29, No.4, pp. 10430 – 10440

Fithri, P. and Regina, Y. S. 2015. Analysis of Alsintan CV Company Productivity Measurement. Cherry Sarana Agro. *Journal of Industrial System Optimization*. 14(1):138-155.

Gupta, R. and Dey, SK. 2012. Development of Productivity Measurement Model for Tea Industry. *Journal of Engineering and Applied Sciences* Vol. 5(12), 16-25.

Hakim, L. 2010. Analysis of the Influence of Motivation on Increasing Employee Work Productivity of PT. Diamond Indonesia. *Journal of Industrial Economics.* 1(1): 1-8.

Hariastuti, N. L. P. 2013. Cobb-Douglas Function Analysis to Improve Labor Use Efficiency and Productivity. *Journal of Industrial Engineering.* 6(2): 1-10.

Hartanto, H. A and Dwi, H. J. U. 2013. Form of Public-Private Cooperation for Graving Dock Construction and Shipyard Management Using the Anallytical Hierachi Process (AHP) Method. *Journal of Engineering.* 34(1):53

Herjanto, Eddy. 2016. Operations Management. Jakarta: Grasindo.

Kulsum., E. N. Andrian and P. B. Katili. 2017. Analysis of Company Productivity Measurement of PT. XYZ. *IENACO National Seminar.* ISSN: 2337-4349. 406-414.

Kusumanto, D. 2016. Analysis of Opportunities for the Development of the Palm Sugar Industry in Supporting National Sugar Self-Sufficiency. *Journal of Tropic Agriculture*. 3(2): 150-170.

Liong, T. C. Y. 2010. Successful in Achieving Business. Jakarta: PT. Kompas Media Nusantara.

Nugroho, P and Triwilaswandio, W. P. 2012. Modeling the risk of increasing the basic electricity tariff on the production cost of new ships. *Journal of Engineering.* 1(1): 5-9.

Okafor, B. E. 2013. Analysis of the Impact of Labor and Input Materials on Productivity. *International Journal of Engineering and Technology.* 3(3): 245-257.

Parinduri, L., Siti, R. S., and Wage, S. 2018. Economic Age Analysis of Boiling Machines for Replacement Planning (Case Study at PTPN IV ADOLINA PERBAUNGAN Plantation). *Engineering Main Bulletin.* 14(1): 6-13.

Praharsi, Y., iphov, K. S and Dewi, M, S. 2015. Designing Preventive Maintenance Scheduling at PT. Arta Prima Sukses Makmur. Scientific *Journal of Industrial*

Engineering. 14(1): 59-65.
Purnomo, A., Firdaus, M., Sutiksno, D. U., Putra, R. S., & Hasanah, U. (2021, July). Mapping of business intelligence research themes: four decade review. In *2021 IEEE International Conference on Communication, Networks and Satellite (COMNETSAT)* (pp. 32-37). IEEE.
Safrizal, H. B. A., Eliyana, A., Firdaus, M., & Rachmawati, P. D. (2020). The effect of participatory leadership on performance through psychological empowerment and trust-in-supervisors. Systematic Reviews in Pharmacy, 11(11), 1234-1246.
Saiful, A. R and Olyvia, N. 2014. Measurement of Defecator Machine Performance I Using the Overall Equipment Effectiveness Method (Case Study on PT. XY Plantation). *Journal of Engineering and Management in Industrial Systems.* 2(2): 5-11.
Summanth, DJ 1998. *Total Productivity Management.* New York: CRC Corporation.
Yulianti. 2016. Physical Environment Design with Green Building Approach. *Journal of Industrial Engineering.* 17(2): 72-83.
Wildan, M. A. (2020). Employee's productivity at the operation of indonesian railway. The Indonesian Accounting Review, 10(1), 47-50.
Wildan, M. A., Imron, M. A., & Siswati, E. (2021). Macroeconomic factors affecting natural gas export management. International Journal of Energy Economics and Policy, 11(1), 639-644.