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Research Article

Analysis and Evaluation of Productivity Using the Marvin E. Mundel Method and the Productivity Evaluation Tree (PET) at PT. YZ

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A B T R A C T

PT. YZ is currently still not optimal in utilizing the resources it has (input) so that the results (output) produced are not in accordance with the target which results in a decrease in company productivity and so productivity measurements must be carried out in the company. Besides that, at PT. YZ has never conducted a thorough productivity measurement during the production process. Therefore, in this study, productivity measurements were carried out with the aim of knowing the results of measuring productivity levels at PT. YZ, to find out the factors causing a decrease in productivity levels and evaluate productivity against measurement results that have low productivity. The proper method for analyzing these problems is to use the Marvin E Mundel method to measure productivity and the Productivity Evaluation Tree (PET) method is used to evaluate productivity issues. In carrying out processing using this method, it is assisted by the Embarcadero-Dev C ++ Software. Based on the results of research using the Marvin E. Mundel method, it was found that company productivity had decreased, namely that in 2021 total productivity was 1.14 and in 2022 total productivity was 1.13. The cause of the decline in company productivity is that the labor factor is not clearly regulated for sanctions and rewards for the company; the raw material factor is the long distance of delivery from the raw material supplier to the production site; and the energy factor has not yet carried out accurate calculations regarding the use of electricity for the process. Production and machine factors have not yet established a machine maintenance schedule. The evaluation results using the Productivity Evaluation Tree (PET) method show that total productivity has increased; in 2022, total productivity was 1.13, and in 2023, total productivity was 1.15. To increase productivity, this was done by reducing input, namely the number of workers. By reducing the number of workers, productivity increases.

INTRODUCTION

Productivity is one of the factors for the survival of a company, with an increase in productivity indicating the success of a company in carrying out the production process. To increase company productivity from period to period, companies need to measure productivity (Anis et al., 2007; Sumasto, Arliananda, Imansuri, Aisyah, & Purwojatmiko, 2023; Wardhani & Realita, 2022). The purpose of measuring productivity is to find out whether productive efficiency has increased or decreased. In companies, productivity is used to find out how optimal the company is in utilizing its resources to achieve a desired target (Sumasto, Arliananda, Imansuri, Aisyah, & Pratama, 2023; Sumasto, Maharani, et al., 2023; Surya et al., 2021; Zadry & Darwin, 2020). However, not all companies utilize their resources optimally and produce the desired targets, one of which is PT. YZ. Therefore, it is necessary to measure productivity to increase and improve productivity(Abbes et al., 2018; Lestari et al., 2019; Ollifia & Lukmandono, 2019; Utomo & Purnama, 2023)

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PT. YZ is a limited liability company currently engaged in production, sales of raw materials and food and beverage franchising. This company's main production is producing kebab meat and selling raw materials and kebab food. Location PT. YZ consists of three places, namely the first is located on Jl. Ampera Raya, Ragunan, Kec. Ps. Sunday, the city of South Jakarta is the head office of PT. YZ's second location is in Pasar Kita Pamulang, South Tangerang, and the third is located in Palmerah, West Jakarta. This location is a production site for PT. YZ products.

The problem that occurs is that the company has not optimally utilized its resources (input) so that the results (output) produced are not in accordance with the target which results in a decrease in company productivity and so productivity measurements must be carried out at the company (Sri Rejeki et al., 2013; Utomo & Purnama, 2023). Besides that, at PT. YZ has never measured productivity as a whole during the production process so it is unclear whether the company has experienced a decrease or increase in productivity, because the company only sees the targets achieved as a measure of the company's productivity. The following is production data for the period July 2021-June 2022 (Table 1.).

Table 1. Production Data for the Period July 2021-June 2022

Month	Input (Kg)	Target (Pcs)	Output (Pcs)	Percentage	Percentage not achieved	Information
Jul-21	400	900	900	100%	0%	Achieved
Agu-21	400	900	800	88.9%	11.1%	Not Achieved
Sep-21	400	900	900	100%	0%	Achieved
Oct-21	400	900	880	97.8%	2.2%	Not Achieved
Nov-21	400	900	765	85%	15%	Not Achieved
Dec-21	400	900	900	100%	0%	Achieved
Jan-22	400	900	840	93.3%	6.7%	Not Achieved
Feb-22	400	900	900	100%	0%	Achieved
Mar-22	400	900	830	92.2%	7.8%	Not Achieved
Apr-22	400	900	890	98.9%	1.1%	Not Achieved
May-22	400	900	715	79.4%	20.6%	Not Achieved
Jun-22	400	900	755	83.9%	16.1%	Not Achieved
Total	4,800	10,800	10,800		80.6%	

Based on table 1, the amount of output produced tends to not match the desired target. For example, in June 2022 the amount of input used is 400 kg and the target that must be produced from production is 900 PC, but the amount produced is only 755 PC so this amount does not meet the desired target. The total output here is the finished product, while the input is the raw materials to make a product, the raw materials used are beef, and additional spices.

The existence of products produced do not meet the target, this shows PT. YZ has not maximized the use of resources in producing output, resulting in a decrease in productivity so it is necessary to measure productivity with a productivity index and estimated productivity in the next period. From the results of this productivity analysis, strategies can be developed to increase company productivity.

Formulation of the problem

Based on the background of the problems that have been described in this study is how to measure the level of productivity at PT. YZ, how to analyze the factors causing a decrease in productivity levels, and how to evaluate productivity against measurement results that have low productivity.

Research Objectives and Benefits

Based on the formulation of the problem, the purpose of this study was to determine the results of measuring the level of productivity at PT. YZ, to determine the factors causing the decline in productivity levels and to evaluate productivity against measurement results that have low productivity. The research benefits that are expected to provide benefits include the following:

1. For the Company
   From the research results, the company can find out whether the company's productivity is decreasing or increasing, and can find out the causes of the decline in productivity and the company can maximize the use of its resources to be more optimal.
2. For Academics
   It is hoped that it can increase knowledge and insight regarding measuring productivity using the Marvin E. Mundel method and the Productivity Evaluation Tree (PET) and as a reference for other researchers.
3. For Writers
   Can apply industrial engineering knowledge, increase knowledge in measuring productivity and be able to solve problems and provide appropriate solutions to increase productivity.

METHOD

The research was conducted from December 2022 to May 2023 located at PT. YZ which is located at Pasar Kita Pamulang Jl. Pajajaran No. 1, South Tangerang, Banten. The data collection methods include the following:

1. Literature Study
   Literature study is a method of collecting data from books, literature, theses, reports, journals related to the

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problems discussed to support problems that support research objectives in solving the problems discussed. In this research, what is included in the literature study are books, journals or theses which contain productivity, productivity concepts, productivity measurements, the Marvin E. Mundel method and the Productivity Evaluation Tree (PET) method.

2. Field Study
   Field study is a data collection technique to obtain data by going directly to the field. In this study, data was collected directly from the production line at PT. YZ. The field study methods used in the research are as follows:
   a. Interview
      An interview is a collection of data to obtain information directly from the source through a question and answer session. This activity was carried out by asking questions and answers to the person in charge of the production department to obtain information regarding obstacles during the production process. The data obtained in this interview is that in the production section there was a problem that the product results were not in accordance with the company's targets, which was caused by less than optimal utilization of the company's resources.

   b. Documentation
      Documentation is a collection of data or information in written form or other examples such as archives, documents, books, numbers and images that can support research. Data obtained from the documentation method for PT. YZ, namely data taken in the period July 2021-June 2022 includes labor costs, raw material costs, energy costs, machine maintenance costs, machine depreciation costs, product selling prices and employee working hours.

Productivity

Productivity is the ratio between the output produced by a company to the number of inputs used during the production process within a certain time span (Wahyuni, 2017: 6). This productivity is usually calculated as an index or ratio (ratio) of output compared to input and can be expressed in physical measures (physical productivity) and financial measures (financial productivity) (Suhartini & Basjir, 2022; Syahputra & Andriani, 2021). In a company, to find out whether the company is productive or not, productivity must be measured. Productivity measurement is the initial stage in the productivity cycle which functions to determine the company's current level of productivity (Wahyuni, 2017: 26).

Marvin E. Mundel Method

Marvin E. Mundel is a method for measuring productivity which is used as a reference to see increases or decreases in productivity specifically or from each input.

The calculation steps for the Marvin E Mundel method are as follows:

1. Calculating the Deflator
   The deflator is a balancing value or price adjustment to factors coming from the company, where this value is used to obtain a constant price value:

$$d = \frac{IH.PP - IH.PD}{IH.PD}$$

   Information:
   D = Deflator
   IH.PP = Research Period Price Index
   IH.PD = Base Period Price Index

2. Determine Constant Prices
   Constant prices really need to be determined when measuring productivity, because the current price for each input or output is converted to a constant price through the deflator value. The following is the constant price formula:

$$\text{Constant Price} = \frac{Value\ of\ the\ relevant\ period\ \ x\,100}{100 + deflator}$$

3. Calculation of Partial Input Resources (RIP) and Aggregate Output
   Partial Input Resources (RIP) are obtained from the sum of all constant price inputs that have been calculated. Meanwhile, Aggregate Output is obtained from multiplying the amount of output by the selling price per product (Ollifia & Lukmandono, 2019).

4. Calculation of Total Productivity
   Total productivity is a total calculation related to total input or total output in the production process. Following is the calculation formula:
   Total Productivity = Total output / Total input

5. Calculation of Partial Productivity
   For this calculation, we calculate the partial productivity of each type of input used (labor, materials, machine depreciation, machine maintenance, energy).
   Following is the calculation formula:
   Material Partial Productivity =
   Output / Material
   Partial Productivity Other Inputs =
   Output / Other Inputs

6. Calculating the Partial Productivity Index
   Calculation of the partial productivity index by comparing the index value of one of the inputs

(material costs, labor, machine depreciation, machine maintenance and energy). Following is the calculation formula:

IP = {(AOMP/RIMP) / (AOBP/RIBP)} x 100
IP = {(AOMP/AOBP) / (RIMP/RIBP)} x 100

Information:
IP = Productivity Index
AOMP = Aggregate Output for the period measured
AORP = Aggregate Output for the base period
RIMP = Inputs for the period being measured
RIBP = Inputs for the base period

7. Analysis of Productivity Changes
The change in total productivity is the difference or magnitude of the difference between total productivity in period t and total productivity in period t-1 (Sri Rejeki et al., 2013). Here is the calculation formula:

$$\Delta PT\ it = \frac{\Delta Oit - (\Delta Iit)(PTit - 1)}{Iit - 1 + \Delta Iit} where\ t \geq 1$$

a. If ΔPT it = 0. then there is no difference in total productivity in periods t and t-1
b. If $\Delta PT\ it > 0$. then total productivity in period t is higher than total productivity in period t-1.
c. If $\Delta PT\ it < 0$. then total productivity in period t is lower than total productivity in period t-1.

8. Analysis of Total Productivity with Partial Productivity Function
By analyzing partial productivity input factors, you can find out which input factors provide the greatest value contribution, so you can know the input factors that need to be evaluated.
The following is the formula used:

$$W_{IH} = \frac{I_{IH}}{I_{IH} + I_{IM} + I_{IE} + I_{IC} + I_{ID}}$$

$$W_{IM} = \frac{I_{IM}}{I_{IH} + I_{IM} + I_{IE} + I_{IC} + I_{ID}}$$

$$W_{IE} = \frac{I_{IE}}{I_{IH} + I_{IM} + I_{IE} + I_{IC} + I_{ID}}$$

$$W_{IC} = \frac{I_{IC}}{I_{IH} + I_{IM} + I_{IE} + I_{IC} + I_{ID}}$$

$$W_{ID} = \frac{I_{IH}}{I_{IH} + I_{IM} + I_{IE} + I_{IC} + I_{ID}}$$

Information:
W_{IH} = *Weight corresponding to input human*
W_{IM} = *Weight corresponding to input material*
W_{IE} = *Weight corresponding to input energy*
W_{IC} = *Weight corresponding to input capital working*
W_{ID} = *Weight corresponding to input depreciation*
IH = *Human input*
IM = *Material input*
IE = *Energy input*
IC = *Capital working input*
ID = *Depreciation input*

Productivity Evaluation Tree (PET)

Productivity Evaluation Tree (PET) is referred to as productivity evaluation, this method assesses productivity achievements and estimates productivity in the following period (Anis et al., 2007; Ollifia & Lukmandono, 2019). The aim of this method is to obtain the information data needed to later be used in estimating productivity in the next period.
The Productivity Evaluation Tree (PET) method for evaluating productivity has two methods, namely as follows:

1. Method I

$$PT'_{it-2} = \alpha PT_{it-2} + (1-\alpha)\ PT_{it-2}'$$

PT'$_{it-2}$ = Estimated total productivity of product i for period t-2
PT'$_{it-2}$ = Actual total productivity of product i for period t-2
α = Parameter (smoothing constant) where $0 \leq \alpha \leq 1$

$$a = \frac{2}{M+1}$$

Variations and percentage variations in productivity in method 1 can be calculated as follows:

$$VPT^{(1)}{}_{it} = PT_{12} - PT_{12}'$$

$$PVPT^{(1)}{}_{it} = \left[\frac{PT_{12}}{PT'_{12}} - 1\right] \text{ x } 100$$

Information:
VPT = Total productivity variation
PVPT = Percentage variation in total productivity

2. Method II
In the method, the two formulas used are as follows:

$$O*_{it} = O_{it-1} + \Delta O*_{it}$$
$$I*_{it} = I_{it-1} + \Delta I*_{it}$$
$$TP*_{it} = \frac{O*_{it}}{I*it}$$

Information:
$O*_{it}$ = Output value of product i in period t
$I*_{it}$ = Input value for product i in period t
$TP*_{it}$ = Total productivity for product i in the period.

RESULT AND DISCUSSION

Data collection

In this research, the data collection used to measure productivity in companies is labor costs, raw material costs, energy costs, machine maintenance costs, machine depreciation costs and selling price or output costs. The following is the data collection table 2.

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Tabel 2. Data collection

Month	Labor costs	Raw Material Costs	Energy Costs	Machine Maintenance Costs	Depreciation Expenses	Total Selling price
Jul-21	Rp 48,292,049	Rp 42,994,000	Rp 7,830,529	Rp 450,000	Rp 601,935	Rp 117,000,000
Agu-21	Rp 43,901,863	Rp 42,994,000	Rp 7,833,759	Rp 450,000	Rp 547,214	Rp 104,000,000
Sep-21	Rp 43,901,863	Rp 42,994,000	Rp 7,940,703	Rp 430,250	Rp 547,214	Rp 117,000,000
Oct-21	Rp 48,292,049	Rp 42,994,000	Rp 7,949,727	Rp 450,000	Rp 601,935	Rp 114,400,000
Nov-21	Rp 43,353,089	Rp 42,994,000	Rp 8,024,476	Rp 410,000	Rp 540,374	Rp 99,450,000
Dec-21	Rp 46,371,343	Rp 42,994,000	Rp 8,056,671	Rp 400,220	Rp 577,995	Rp 117,000,000
Jan-22	Rp 43,353,089	Rp 45,454,500	Rp 7,934,354	Rp 420,125	Rp 559,993	Rp 113,400,000
Feb-22	Rp 46,096,956	Rp 45,454,500	Rp 7,847,239	Rp 475,000	Rp 595,436	Rp 121,500,000
Mar-22	Rp 46,096,956	Rp 45,454,500	Rp 8,182,664	Rp 410,000	Rp 595,436	Rp 112,050,000
Apr-22	Rp 46,096,956	Rp 45,454,500	Rp 7,972,118	Rp 465,000	Rp 595,436	Rp 120,150,000
May-22	Rp 38,962,903	Rp 45,454,500	Rp 8,025,479	Rp 420,000	Rp 503,285	Rp 96,525,000
Jun-22	Rp 43,901,863	Rp 45,454,500	Rp 7,803,681	Rp 415,000	Rp 567,082	Rp 101,925,000

Marvin E Mundel Method Calculations

1. Deflator Calculation
   In determining the deflator value, the data used is price index data obtained from the Central Statistics Agency (Table 3.). The deflator value is used to calculate constant prices. The deflator is calculated using the formula:

$$d = \frac{IH.PP - IH.PD}{IH.PD}$$

   With July 2021 as the base period for determining the price index in 2021 and 2022:

$$\text{Deflator for August 2021} = \frac{106.01 - 105.84}{105.84} = 0.002$$

Table 3. Deflator Values

Month	Price Index	Deflator
Jul-21	105.84	0.000
Agu-21	106.01	0.002
Sep-21	105.94	0.001
Oct-21	106.03	0.002
Nov-21	106.21	0.003
Dec-21	106.94	0.010
Jan-22	107.43	0.015
Feb-22	107.55	0.016
Mar-22	108.63	0.026
Apr-22	109.68	0.036
May-22	109.73	0.037
Jun-22	110.38	0.043

2. Constant Price Calculation
   The current price of each input or output is converted to a constant price through the deflator value. To calculate constant prices, all inputs are calculated, namely labor, raw materials, energy (Table 4.), machine maintenance, machine depreciation and output (Table 5.).
   The constant price formula is as follows:

$$\text{Constant Price} = \frac{Value\ of\ the\ relevant\ period\ \ x\,100}{100 + deflator}$$

   The following is an example of calculating constant prices for input labor costs in August 2021:

$$\text{Constant Price} = \frac{\text{Rp } 48{,}292{,}049 \text{ x } 100}{100 + 0.002} = \text{Rp } 48{,}292{,}049$$

Table 4. Results of Constant Prices for Labor, Raw Materials, Energy

Month	Labor (Rp)	Raw Material (Rp)	Energy (Rp)
Jul-21	48,292,049	42,994,000	7,830,529
Agu-21	43,901,158	42,993,309	7,833,634
Sep-21	43,901,448	42,993,594	7,940,628
Oct-21	48,291,182	42,993,228	7,949,584
Nov-21	43,351,574	42,992,497	8,024,196
Dec-21	46,366,524	42,989,532	8,055,834
Jan-22	43,346,578	45,447,673	7,933,162
Feb-22	46,089,509	45,447,157	7,845,971
Mar-22	46,084,808	45,442,521	8,180,508
Apr-22	46,080,237	45,438,015	7,969,227
May-22	38,948,588	45,437,800	8,022,530
Jun-22	43,883,039	45,435,011	7,800,335

Table 5. Results of Constant Prices for Machine Maintenance, Machine Depreciation and Output

Month	Machine maintenance (Rp)	Machine Depreciation (Rp)	*Output* (Rp)
Jul-21	450,000	601,935	117,000,000
Agu-21	449,993	547,205	103,998,330
Sep-21	430,246	547,209	116,998,895
Oct-21	449,992	601,924	114,397,946
Nov-21	409,986	540,355	99,446,524
Dec-21	400,178	577,935	116,987,841
Jan-22	420,062	559,909	113,382,967
Feb-22	474,923	595,339	121,480,373
Mar-22	409,892	595,279	112,020,471
Apr-22	464,831	595,220	120,106,424
May-22	419,846	503,100	96,489,537
Jun-22	414,822	566,838	101,881,298

3. Calculation of Partial Input Resources (RIP) and Aggregate Output
   a. Partial Input Resources (RIP)
   Partial Input Resources (RIP) are obtained from the sum of all constant price inputs that have been calculated (Table 6.).

RIP = Constant Price of Labor + Constant Price of Raw Materials + Constant Price of Energy + Constant Price of Machine Maintenance + Constant Price of Machine Depreciation

RIP July 2021 = Rp 48,292,049 + Rp 42,994,000 + Rp 7,830,529 + Rp450,000 + Rp 601,935

= Rp 100,168,513

Table 6. Partial Input Resources (RIP) Calculation Results

Month	RIP (Rp)
Jul-21	100,168,513
Agu-21	95,725,298
Sep-21	95,813,125
Oct-21	100,285,911
Nov-21	95,318,607
Dec-21	98,390,002
Jan-22	97,707,383
Feb-22	100,452,901
Mar-22	100,713,007
Apr-22	100,547,530
May-22	93,331,864
Jun-22	98,100,046

   b. Aggregate Output
   This Aggregate Output calculation is obtained from multiplying the total output by the selling price per product (Table 7.).

Aggregate Output = Production Quantity x Selling Price

Aggregate output for July 2021
= 900 x Rp 130.000
= Rp 117.000.000

Table 7. Aggregate Output Calculation Results

Month	Production quantity	Selling price (Rp)	Aggregate Output (Rp)
Jul-21	900	130,000	117,000,000
Agu-21	800	130,000	104,000,000
Sep-21	900	130,000	117,000,000
Oct-21	880	130,000	114,400,000
Nov-21	765	130,000	99,450,000
Dec-21	900	130,000	117,000,000
Jan-22	840	135,000	113,400,000
Feb-22	900	135,000	121,500,000
Mar-22	830	135,000	112,050,000
Apr-22	890	135,000	120,150,000
May-22	715	135,000	96,525,000
Jun-22	755	135,000	101,925,000

4. Calculation of Total Productivity
   Following is the calculation formula:
   Total Productivity = Total output / Total input
   The following is an example of calculating total productivity for July 2021 (Table 8.):

$$\text{Total Productivity} = \frac{\text{Rp } 117{,}000{,}000}{\text{Rp } 100{,}168{,}513} = 1.17$$

Table 8. Total Productivity Results

Month	*Input* Total (Rp)	*Output* Total (Rp)	Total Productivity
Jul-21	100,168,513	117,000,000	1.17
Agu-21	95,725,298	104,000,000	1.09
Sep-21	95,813,125	117,000,000	1.22
Oct-21	100,285,911	114,400,000	1.14
Nov-21	95,318,607	99,450,000	1.04
Dec-21	98,390,002	117,000,000	1.19
Jan-22	97,707,383	113,400,000	1.16
Feb-22	100,452,901	121,500,000	1.21
Mar-22	100,713,007	112,050,000	1.11
Apr-22	100,547,530	120,150,000	1.19
May-22	93,331,864	96,525,000	1.03
Jun-22	98,100,046	101,925,000	1.04

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5. Calculation of Partial Productivity and Productivity Index With Embarcadero- Dev C++

   In this processing, Embarcadero-Dev C++ software is used to calculate partial productivity and productivity index.

   The following are the results of calculating partial productivity and productivity index (Figure 1-10):

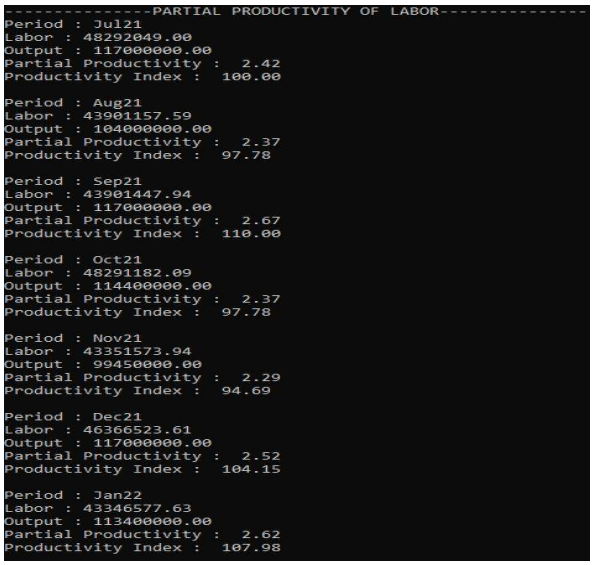

Fig 1. Output of Running Program in Embarcadero-Dev C++

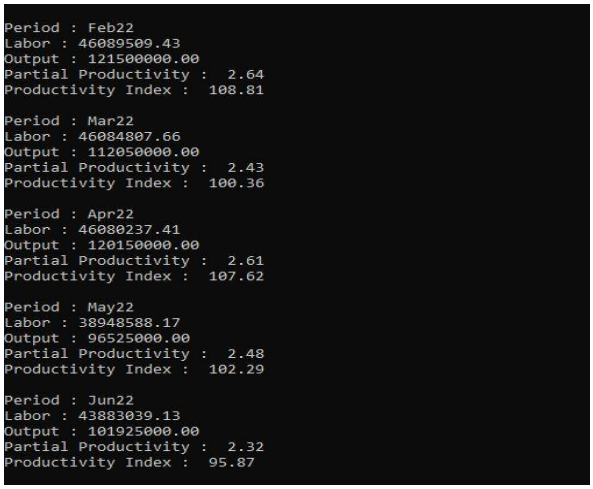

Fig 2. Output Running Program in Embarcadero-Dev C++

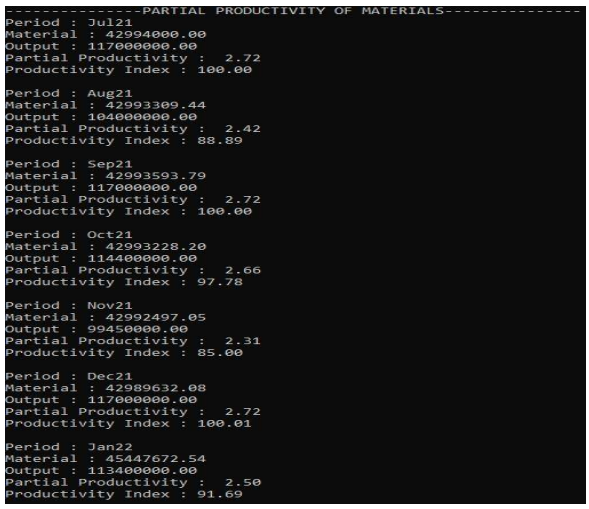

Fig 3. Output Running Program in Embarcadero-Dev C++

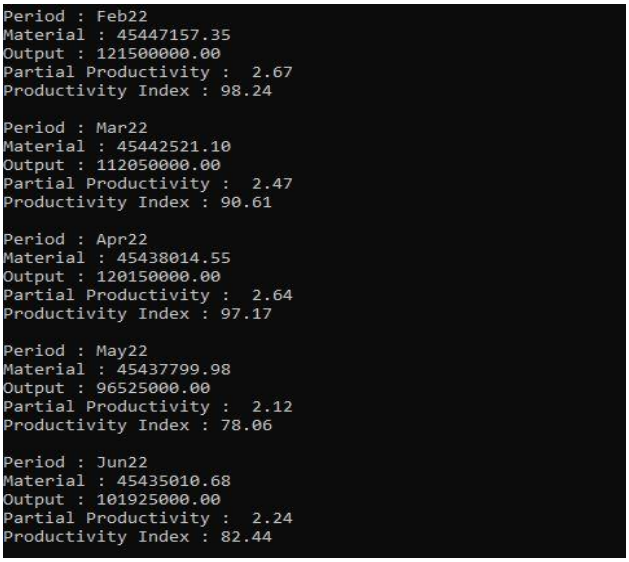

Fig 4. Output Running Program in Embarcadero-Dev C++

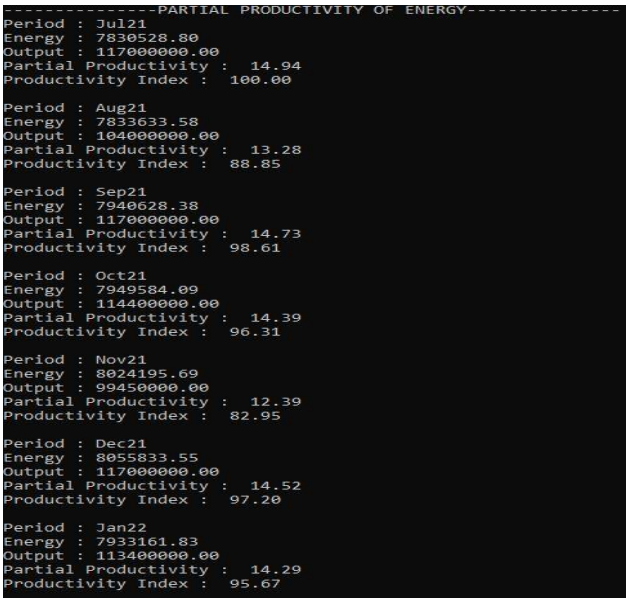

Fig 5. Output Running Program in Embarcadero-Dev C++

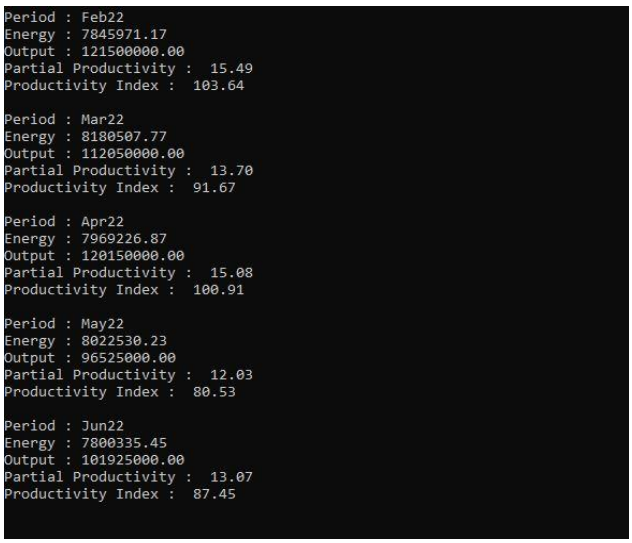

Fig 6. Output Running Program di Embarcadero-Dev C++

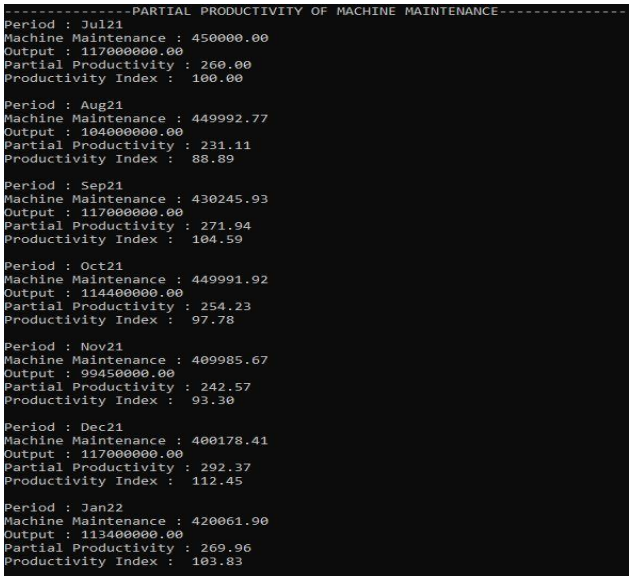

Fig 7. Output Running Program di Embarcadero-Dev C++

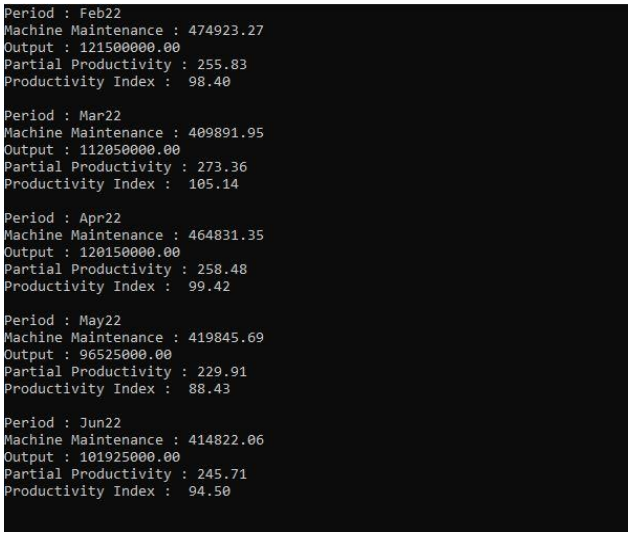

Fig 8. Output Running Program di Embarcadero-Dev C++

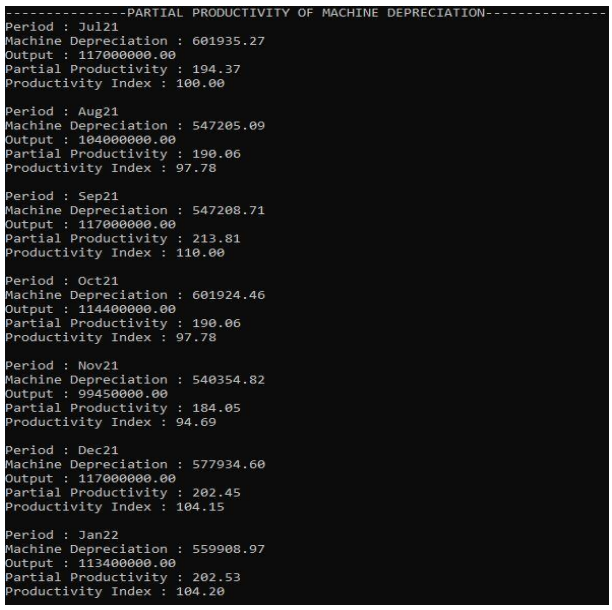

Fig 9. Output Running Program di Embarcadero-Dev C++

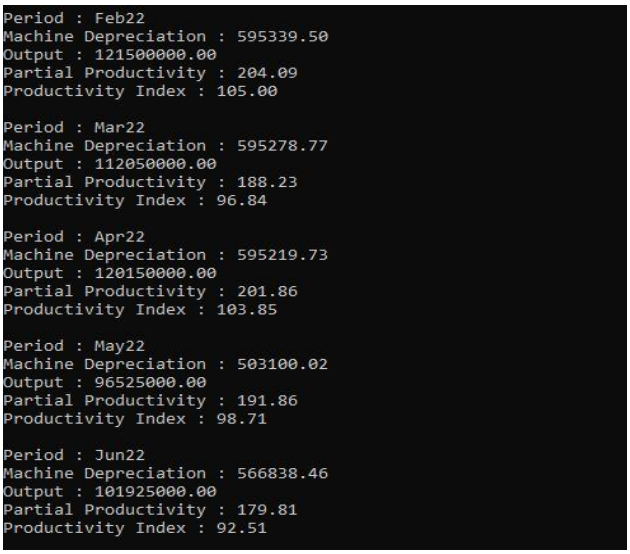

Fig 10. Output Running Program di Embarcadero-Dev C++

6. Total and Partial Productivity in 2021 and 2022

After obtaining the partial productivity calculation results using Embarcadero-Dev C++ software, a recapitulation of the results of partial productivity and total productivity for 2021 and 2022 was carried out. The following is the calculation for recapitulating the results of partial productivity and total productivity:

$$\text{Total Productivity} : \frac{\text{Total Productivity Amount}}{\text{Number of month}}$$

Total Productivity in 2021:

$$\text{Total Productivity} = \frac{1{,}17 + 1{,}09 + 1{,}22 + 1{,}14 + 1{,}04 + 1{,}19}{6}$$

$$= 1{,}14$$

$$\text{Partial Productivity} = \frac{\text{Total partial productivity of each factor}}{\text{Number of month}}$$

Partial Productivity of Labor Factors in 2021:

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Partial Productivity = $\frac{2,42 + 2,37 + 2,67 + 2,37 + 2,29 + 2,52}{6}$

= 2,44

The following are the results of calculating total productivity and partial productivity (Table 9.).

Table 9. Total and Partial Productivity Results

Productivity	Year	
	2021	2022
Total	1,14	1,13
Partial		
Labor	2,44	2,52
Raw Material	2,59	2,44
Energy	14,04	13,94
Machine Maintenance	258,70	255,54
Machine Depreciation	195,80	194,73

From table 9 it can be seen that the total productivity value in 2022 has decreased compared to 2021, apart from that the partial productivity value in 2022 from each factor such as raw materials, energy, machine maintenance and machine depreciation has also decreased from 2021, while for other factors workforce increases.

7. Productivity Index

After obtaining the partial productivity index results from calculations using Embarcadero-Dev C++ software, a partial productivity index recapitulation was carried out which can be seen in table 10.

Table 10. Productivity Index

Month	Partial Productivity (%)				
	Labor	Material	Energy	Machine Maintenance	Machine Depreciation
Jul-21	100,00	100,00	100,00	100,00	100,00
Agu-21	97,78	88,89	88,85	88,89	97,78
Sep-21	110,00	100,00	98,61	104,59	110,00
Oct-21	97,78	97,78	96,31	97,78	97,78
Nov-21	94,69	85,00	82,95	93,30	94,69
Dec-21	104,15	100,01	97,20	112,45	104,15
Jan-22	107,98	91,69	95,67	103,83	104,20
Feb-22	108,81	98,24	103,64	98,40	105,00
Mar-22	100,36	90,61	91,67	105,14	96,84
Apr-22	107,62	97,17	100,91	99,42	103,85
May-22	102,29	78,06	80,53	88,43	98,71
Jun-22	95,87	82,44	87,45	94,50	92,51

Based on the table of 10 inputs used at PT. YZ raw material productivity index decreased the most with a percentage value of 78,06% in June 2022, which means a decrease of 21,94%, and the productivity index that experienced the highest increase was machine maintenance input in December 2021 amounted to 112,45%, which means an increase of 12,45%.

8. Analysis of Productivity Changes

In Research at PT. YZ first determines that period (t) is total productivity in 2022 and period (t-1) is total productivity in 2021. Analysis of changes in productivity can be seen in table 11.

Table 11. Calculation of Productivity Changes

Description	Year	
	2021	2022
Output (Rp)	668,850,000	665,550,000
Input (Rp)	585,701,456	590,852,731
Total Productivity (Rp/Rp)	1.14	1.13
ΔOit (Rp)	-3,300,000	
ΔIti(Rp)	5,151,274	
ΔPTit	-0.02	

ΔPt it < 0. So total productivity in the 2022 period is lower than total productivity in the 2021 period. This occurs because of the slight difference between the use of input and output in 2021 from 2022.

9. Analysis of Total Productivity with Partial Productivity Function

   The following is the calculation of weight corresponding to human input in July 2021:

$$W_{IH} = \frac{I_{IH}}{I_{IH} + I_{IM} + I_{IE} + I_{IC} + I_{ID}}$$

$$W_{IH} = \frac{Rp\ 48{,}292{,}049}{Rp\ 48{,}292{,}049 + Rp\ 42{,}994{,}000 + Rp\ Rp\ 7{,}830{,}529 + Rp\ 450{,}000 + Rp\ 601{,}935}$$

   = Rp 0.482

Table 12. *Weight Corresponding Input Factor*

Month	I_{IH}	I_{IM}	I_{IE}	I_{IC}	I_{ID}
Jul-21	0.482	0.429	0.078	0.004	0.006
Agu-21	0.459	0.449	0.082	0.005	0.006
Sep-21	0.458	0.449	0.083	0.004	0.006
Oct-21	0.482	0.429	0.079	0.004	0.006
Nov-21	0.455	0.451	0.084	0.004	0.006
Dec-21	0.471	0.437	0.082	0.004	0.006
Jan-22	0.444	0.465	0.081	0.004	0.006
Feb-22	0.459	0.452	0.078	0.005	0.006
Mar-22	0.458	0.451	0.081	0.004	0.006
Apr-22	0.458	0.452	0.079	0.005	0.006
May-22	0.417	0.487	0.086	0.004	0.005
Jun-22	0.447	0.463	0.080	0.004	0.006

   Of each of the input factors (Table 12.), those that make the biggest contribution and that most influence total productivity are the labor (human input) and raw materials (material input) factors.

10. Fishbone Diagram

    In analyzing low productivity, a fishbone diagram (cause and effect) can be used to identify the factors causing a decrease in productivity related to the inputs used, namely labor, raw materials, energy and machines (Figure 11.).

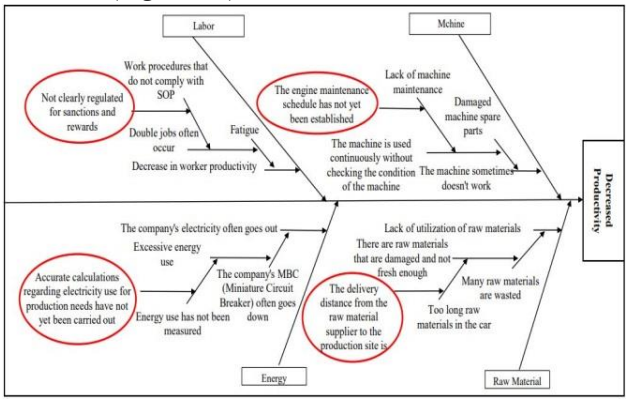

Fig 11. Fishbone Diagram of Productivity

   Based on Figure 11, the cause of the decline in company productivity is that the labor factor is not clearly regulated for sanctions and rewards for the company, the raw material factor is the distance between delivery from raw material suppliers to the production site, and the energy factor has not yet carried out accurate calculations regarding usage. electricity for the production process and the machine factor has not yet established a machine maintenance schedule.

PET (Productivity Evaluation Tree) Method Calculation

Productivity evaluation tree (PET) is referred to as productivity evaluation, this method assesses productivity achievements and estimates of productivity in the next period. In the productivity evaluation tree, there is a procedure for evaluating total productivity between two periods, namely period 1 (2021) or t-2, period 2 (2022) or t-1 and the estimated total productivity in 2023 (t) can be explained as follows:

Total productivity for period 1 = 1.14
Total productivity for period 2 = 1.13

The calculation of the PET method is done using Embarcadero-Dev C++ software. The following are the results of the PET method calculation using software Embarcadero-Dev C++ (Figure 12.).

```
PERIOD:
1st year = 1.14
2nd year= 1.13

METHOD 1
Result a: 0.29
==========At the end of period 0=========
 The calculation result :1.14
=========At the end of the 1st period=========
Result a: 0.29
The calculation rsult : 1.14
==========At the end of 2nd period==========
vpt calculation result : -0.01
Result  pvpt : -0.63 %


METHOD 2
Enter the analysis result: Enter O21 : -0.02
Enter difference 0 O* : 665550000
Enter I it-1  :590852731
Enter diffrence I 1 :11144319
Enter diffrence I 2  : 0
The calculation result O*22 : 665549999.98
The calculation result I*it : 579708412.00
 So the results of calculating Total Productivity for 2023 is TP*it= 1.15
--------------------------------
Process exited after 90.19 seconds with return value 0
Press any key to continue . . .
```

Fig 12. PET Method Calculation Results Embarcadero-Dev C++ software

From the calculation of total productivity (ΔPT) the result is -0,02 because ΔPt it < 0, so total productivity in the 2022 period is lower than total productivity in the 2021 period. Which is according to the calculation of the total productivity analysis with the partial productivity function which needs to be improved and Minimization is in terms of the use of labor and use of raw materials because these

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inputs make the biggest contribution and most influence total productivity.

From calculations using the Productivity Evaluation Tree (PET) method with Embarcadero-Dev C++ software in Figure 12, the estimate increased by 1,15 for the 2023 period from the previous period, namely 1,13. Using the productivity evaluation method or PET shows that increasing total productivity can be done by reducing input. By reducing labor, productivity increases.

CONCLUSION

Based on the results of data processing and analysis regarding the evaluation and analysis of productivity measurements at PT. YZ, it can be concluded that, based on the results of measuring the level of productivity at PT. YZ, Tbk, using the Marvin E. Mundel method, experienced a decline, namely that in 2021 total productivity was 1.14 and in 2022 total productivity was 1.13. And this is also stated by the lowest productivity index for each input; for example, raw material input in May 2022 was 78.06%, which means a decrease of 21.94% (= 78.06-100). A company's productivity index that is below 100% and whose value is decreasing indicates that the company's productivity is decreasing.

Apart from that, the main cause of the decline in company productivity is that the labor factor is not clearly regulated for sanctions and rewards for the company, the raw material factor is the distance between delivery from the supplier of raw materials to the production site, and the energy factor has not been accurately calculated regarding usage energy for the production process, so that energy use is not controlled, and the machine factor has not yet established a machine maintenance schedule, so that machine maintenance is not carried out routinely.

Based on these problems, an evaluation was carried out using the Productivity Evaluation Tree (PET) method, showing that total productivity has increased; in 2022, the total productivity was 1.13, and in 2023, the total productivity was 1.15. To increase total productivity, this can be done by reducing input. By reducing the number of workers, productivity increases.

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