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Productivity Improvement of Production Unit Using Objective Matrix (OMAX) Method at PT. X

Khusnul Kotimah*, Enny Aryanny

Department of Industrial Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Jl. Rungkut Madya No.1, Gunung Anyar, Surabaya 60294 Indonesia

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A B S T R A C T

PT. X is one of the industries in Indonesia that processes sugar cane into sugar and is one of the suppliers of national sugar needs. PT. X's production activities in 2022 still cannot reach the target and production per period has fluctuated. Therefore, this study was conducted with the aim of knowing the current level of total and partial productivity and can provide suggestions for improvement to increase the productivity of sugar production at PT. X in the future. The method used is Objective Matrix (OMAX) with the determination of the weight of the criteria using the AHP method. The criteria used in this study are raw materials, labor, boiler machine working hours, electricity and water. Based on the calculations that have been carried out, it can be seen that partial productivity on raw material criteria, the best productivity ratio owned by the company is 6.97, on labor criteria the ratio is worth 1521.86, on the criteria for boiler machine working hours worth 978.91. In the electricity criteria, the best productivity ratio is 3.89. In the water usage criteria, the highest productivity value is 1.83. The company's highest total productivity achieved was 750.7 in the 6th period of August and the lowest productivity with a value of 73.8 in the 2nd period of June. Improvements were made to all criteria, especially labor criteria and boiler machine working hours. With the application of the OMAX method, PT. X can improve partial productivity and total productivity in the future and identify factors that cause productivity to drop in a certain period.

***Corresponding Author**

Khusnul Kotimah
E-mail: kotimahkhusnul2002@gmail.com

1. INTRODUCTION

The sugar industry is a strategic sector that produces important commodities to fulfill the needs of society, for several industrial sectors sugar users are also important raw materials (Kemenperin, 2022). In this industry, the most important thing that must always be considered is the productivity of its production (Hardi et al., 2019). Productivity is an important factor that must be analyzed and evaluated, which is

about how output is produced based on performance in a period for the survival of a company (Jauhari et al., 2019). Productivity is a function of different performance factors (Penelitian, 2020). Productivity is divided into 2, namely total and partial. Total productivity is the calculation of the ratio between the amount of output and the total input (Suparman, 2020). Efficiency changes from operations can be measured using total productivity (Eddy, 2018), while partial productivity only measures the ratio between the number of outputs and one input only (Suparman, 2020).

Productivity is the ratio between the value of output to the value of input used (Martono, 2019), (Bakhtiar et al., 2018). The elements contained in productivity, namely effectiveness, efficiency and production (Singgih & Gunarta, 2021). Factors that affect productivity need to be known therefore the company must measure its productivity (Mukti et al., 2021). The process to improve productivity is called the productivity cycle (Tebay, 2021). There are 4 stages of the productivity cycle which is often called MEPI, namely measuring (measurement), evaluating (evaluation), planning (planning), and improving productivity (improvement) (Sumanth, 1984).

Like previous relevant research, the analysis method used is Objective Matrix (OMAX) and Analytical Hierarchy Process (AHP) as a supporting method (Kharismayanti & Aulia Puspitaningrum, 2022). The OMAX method is an analytical technique used to measure partial productivity in a company according to criteria that have been selected in accordance with the unit / section to be calculated productivity (Wibisono, 2019). As for the calculation of the weight of the criteria of this study using AHP, there are 3 basic principles of AHP, namely decomposition, comparative judgments and priority synthesis (Irianto et al., 2022). AHP is one of the comprehensive decision-making methods (Parhusip et al., n.d.). For the proposed improvements, this study uses a cause and effect diagram, this diagram is used to explain the factors that cause productivity to decline and the characteristics of productivity (Adhimursandi et al., 2022). To find the factors that cause a decrease in productivity in detail can use this diagram (Rosyidi, 2021). PT X in its production activities in 2022 sometimes has difficulty achieving production targets, therefore the purpose of this study is to determine the level of total and partiall productivity in the sugar production unit at PT X and provide suggestions for improvement to increase productivity in the future.

2. LITERATURE REVIEW

Productivity is the ratio between the volume of output and the amount of input used. Another definition states something similar, namely the ratio between the output of work and the input of resources used in the process of creating wealth (Martono, 2019). Productivity is therefore expressed by the following equation:

Productivity = Output/Input (1)

OMAX is a partial productivity measurement method to monitor the productivity of each part by weighting to obtain a total productivity index. This measurement model is characterized by combining work group productivity criteria in a matrix. The results of this measurement become an objective performance assessment in each section and a solution can be found to the cause of the decline in productivity. The OMAX method is able to evaluate existing performance based on predetermined indicators to improve the performance process for the better (Ramayanti & Sastraguntara, 2020).

The stages in data processing using the OMAX method are as follows (Aziza & Suwignjo, 2019):

1. Determination of Criteria
2. Performance Ratio Calculation
3. The productivity performance that will be measured is converted into a ratio. Raw Material Productivity Criteria Performance
$$= \frac{(Production\ Results\ (tons)}{(\text{Total use of raw materials (tons)}} \quad (2)$$
4. Determination of average productivity value (score 3)
5. Determination of the highest productivity value (score 10)
6. Determination of the Lowest Productivity Value (score 0)
7. Determination of realistic productivity value (score 1-2 and 4-9)

8. Determination of score, weight, and value
9. Determination of Performance Indicator

$$IP = \frac{(Current - Previous)}{Previous \times 100\%} \quad (3)$$

The AHP method is a decision support system using pairwise matrix calculations. The use of AHP begins with creating a hierarchical or network structure of the problem to be studied. In the hierarchy there are main objectives, criteria, sub-criteria and alternatives that will be discussed (RMS, Anita Sindar & Purba, 2018). The reason for choosing AHP is because AHP is a form of decision-making model that is suitable for multicriteria and multi-alternative problems. AHP is used to solve complex and unstructured problems into groups, by organizing these groups into a hierarchy, then entering numerical values as a substitute for human perception in making relative comparisons. With a synthesis, it will be determined which elements have the highest priority (Mahendra & Putri, 2019).

The cause and effect diagram was developed by Dr. Kaoru Ishikawa in 1943. A cause and effect diagram is a problem-solving tool that systematically investigates and analyzes all potential or real causes that produce a single effect. On the other hand, it is an efficient tool that equips organizational management to explore the possible causes of problems. These diagrams can aid problem solving by "collecting and organizing possible causes, achieving a common understanding of the problem, exposing gaps in existing knowledge, ranking the most likely causes, and studying each cause. Common categories of cause and effect diagrams usually include six elements (causes) such as environment, materials, machines, measurements, people, and methods. Furthermore, "potential causes" may be indicated by arrows entering the main cause arrows (Herjanto, 2018).

3. RESEARCH METHOD

This research is a quantitative study that uses the Objective Matrix (OMAX) method, productivity is partially measured using this method (Ramayanti & Sastraguntara, 2020). Weighting the criteria using AHP, problems that are multi-criteria and multi-objective can be solved using this model (RMS, Anita Sindar & Purba, 2018). The following is problem solving steps in Fig. 1.

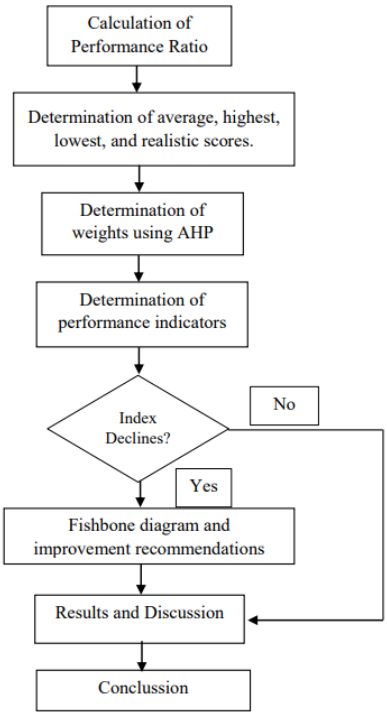

Fig. 1. Problem solving steps

Based on Fig. 1, after knowing the performance indicators, if the productivity index decreases, an analysis of the causes of the decrease in productivity will be carried out and also recommendations for improvement, if there is no decrease in productivity, the discussion will be carried out directly. The research methods explain clearly how the author carried out the research. The method must describe the research design clearly, the replicable research procedures, describe how to summarize and analyze the data. The significant contribution to the body of knowledge should be clearly stated.

The population in this study is the data of production productivity criteria at PT X, while this study uses samples of production productivity criteria in May to September of 2022 which consists of 9 periods. The criteria used in this study are raw materials (ratio 1), labor (ratio 2), boiler machine working (ratio 3), electricity (ratio 4) and water (ratio 5). Data collection in this study comes from primary data sourced from the results of questionnaires and interviews to the Head of the Production Unit of PT X. The data that has been collected through interviews and questionnaires will then be

processed to determine the weight of the criteria using Expert Choice software.

4. RESULT AND DISCUSSION

4.1 Criteria Performance Calculation

After determining the criteria to be calculated, the next step is to determine the performance value of the five criteria, obtained by comparing the ratio of input to output of each criterion from period 1 to period 9, namely May to September 2022. the five criteria are raw materials, labor, boiler machine working, electricity and water. The calculation results are in Table 1. The calculation of the ratio of each criterion is as follows :

$$\text{Ratio 1}=\frac{Production\ Results\ (tons)}{\text{Total use of raw materials (tons)}} \text{ x } 100\%$$

$$\text{Ratio 2} = \frac{Production\ Results\ (tons)}{\text{Labor use (Person)}} \text{ x } 100\%$$

$$\text{Ratio 3} = \frac{Production\ Results\ (tons)}{\text{Boiler engine usage (Hours)}} \text{ x } 100\%$$

$$\text{Ratio 4} = \frac{Production\ Results\ (tons)}{\text{Electricity consumption (Kwh)}} \text{ x } 100\%$$

$$\text{Ratio 5} = \frac{Production\ Results\ (tons)}{\text{Water consumption (M3)}} \text{ x } 100\%$$

Table 1 shows the performance ratio of each criterion from period 1 to 9 May to September 2022, the maximum value (level 10) is the highest value of each criterion, the minimum value (level 0) is the lowest value of each criterion and the average value (level 3) is the average value of each criterion.

Table 1. Performance ratio of each criterion

Month	Period	Raw Materials (Ton)	Labor (Person)	Boiler Machine Working (Hours)	Electricity (Kwh)	Water (M^3)
May	1	6,88	**850,20**	724,14	3,19	1,81
June	2	5,71	873,68	**599,44**	3,49	1,50
	3	6,12	959,51	759,62	**3,89**	1,60
July	4	6,16	1.344,13	864,58	3,68	1,62
	5	**5,57**	1.333,60	915,00	3,80	**1,46**
August	6	6,49	**1.521,86**	**978,91**	3,85	1,70
	7	6,24	1.053,04	722,50	3,18	1,64
Sept	8	**6,97**	1.184,62	812,78	3,33	**1,83**
	9	6,39	911,34	644,99	**2,51**	1,68
Average (Level 3)		6,28	1.114,66	780,22	3,43	1,65
Minimum (Level 0)		5,57	850,20	599,44	2,51	1,46
Maximum (Level 0)		6,97	1.521,86	978,91	3,89	1,83

4.2 Weight Calculation Using AHP

In calculating this weighting is done by discussing with factory leaders to determine the ratio which is the most important among others but with no exclusion of the others. Determining the weight value of criteria is a comparison of which criteria are the most important to the less important criteria. The greater the weight, the more influential the criteria are on productivity. The criteria used are raw materials, labor, boiler machine working hours, electricity and water. Results of AHP weight calculation using expert choice software. The results of calculating the weight of each criterion with expert choice software are shown in Table 2.

Table 2. Weight of each criterion

No	Criteria	Weight	%
1	Raw materials	0.452	45.2%
2	Labor	0.283	28.3%
3	Boiler machine working	0.168	16.8%
4	Electricity	0.063	6.3%
5	Water	0.034	3.4%

In Table 2 above, it is known that the most influential criterion is the raw material criterion with a weight of 0.452 and the lowest influential

criterion is the water criterion with a weight of 0.034.

4.3 Measurement of Performance Indicators

In measuring productivity with the Objective Matrix (OMAX) model, there is a matrix body consisting of 10 types of levels that have their respective values. The determination of the score is obtained from the ratio value of the criteria that is closest to the level level in the matrix. The weight is the result of questionnaire processing using AHP which can be seen in Table 2, while the value is obtained from multiplying the weight and score. In this matrix there are performance indicators consisting of: current (current period productivity value), previous (previous period productivity value), and index productivity (IP) which is the index of productivity change. After doing the calculation, the productivity measurement results are shown in Table 3 (example period 9 September 2022). Performance ratio in table 3 can be seen in Table 2 above.

Based on Table 3, in period 9 (compared to period 8) there was a decrease in productivity, it happened because the IP (productivity index) value was negative (-) which amounted to -67.50 and the current decreased from 685.3 to 222.7. This is due to a decrease in the score and value of each criterion compared to the score and value of the previous period.

In Table 4 is a recapitulation of the productivity level and productivity index for each period. the highest index value occurred in period 3 because it experienced a surge in productivity levels which initially amounted to 73.8 to 222.1. while the highest productivity level occurred in period 6 at 750.7 and the lowest productivity level occurred in period 2 at 73.8, for the current value and index for period 9 can be seen in Table 3.

Table 3. Performance indicator matrix period 9 in September 2022

Ratio	Ratio 1	Ratio 2	Ratio 3	Ratio 4	Ratio 5
Performance Ratio	6,39	911,34	644,99	2,51	1,68

Level	Performance Value of Each Level				
Level 10	**6,97**	**1521,86**	**978,91**	**3,89**	**1,83**
Level 9	6,87	1463,69	950,52	3,83	1,80
Level 8	6,78	1405,52	922,14	3,76	1,78
Level 7	6,68	1347,35	893,75	3,70	1,75
Level 6	6,58	1289,18	865,37	3,63	1,73
Level 5	6,48	1231,01	836,99	3,57	1,70
Level 4	6,38	1172,84	808,60	3,50	1,67
Level 3	**6,28**	**1114,66**	**780,22**	**3,43**	**1,65**
Level 2	6,05	1026,51	751,83	3,12	1,59
Level 1	5,81	938,36	723,45	2,82	1,52
Level 0	**5,57**	**850,20**	**599,44**	**2,51**	**1,46**
Score	4	1	0	0	4
Percentage Weight	45,2	28,3	16,8	6,3	3,4
Value	180,8	28,3	0	0	13,6
Performance Indicator				Current	222,7
				Previous	685,3
				Index	-67,50

Table 4. Recapitulation of productivity level and index

Month	Period	The Level of Productivity (Current)	Index of Productivity
May	1	466,8	-
June	2	73,8	-84,19
	3	222,1	200,95
July	4	443,6	99,73
August	6	750,7	92,88
	7	231,8	-69,12
September	8	685,3	195,64
	9	222,7	-67,50

4.4 Score Analysis of Each Criterion

After calculating the total productivity index with the Objective Matrix (OMAX) model, the achievement of each indicator is analyzed. The increase and decrease in productivity index is caused by the increase and decrease in the achievement value of each productivity indicator in each period. Therefore, an analysis is needed to find out how the achievement of each productivity indicator for each period during 2022. Analysis of productivity measurement is measured based on criteria to find criteria with low productivity and need improvement, for the score of each criterion for period 9 is based on the measurement results in Table 3.

Table 5 shows the score of each productivity criterion. From the results of the score of each productivity criterion in Table 5, it can be concluded that all criteria need to be improved again, because all criteria have an unfavorable score of 0 to 2, especially in the labor criteria and boiler machine working hours criteria which have the lowest total score of the other criteria which is 32..

Table 5. Scores for each criterion

Month	Period	Raw Materials (Ton)	Labor (Person)	Boiler Machine Working (Hours)	Electricity (Kwh)	Water (M^3)
May	1	9	0	1	2	9
June	2	1	0	0	4	1
	3	2	1	2	10	2
July	4	2	7	6	7	3
	5	0	7	8	9	0
August	6	5	10	10	9	5
	7	3	2	1	2	3
Sept	8	10	4	4	3	10
	9	4	1	0	0	4
Total		**36**	**32**	**32**	**46**	**37**

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4.5 Productivity Decline Analysis

Based on Table 4, all criteria require improvement because there are still unfavorable values, especially in the criteria of labor and boiler machinery, therefore observations and interviews were made to the head of the production department of PT X regarding the factors that cause low productivity for each criterion and provide suggestions for improvements to increase productivity in the future.

Figure 2 presents the causes of low productivity in each criterion called the

fishbone diagram. This diagram is a diagram that connects cause and effect (Adhimursandi et al., 2022). The cause and effect diagram is used to illustrate the cause of a problem (Adha et al., 2019), (Annai Nashida & Syahrullah, 2021). Fig. 2 illustrates the fishbone that outlines the factors affecting the decline in productivity, so some improvements are proposed as in Table 6.

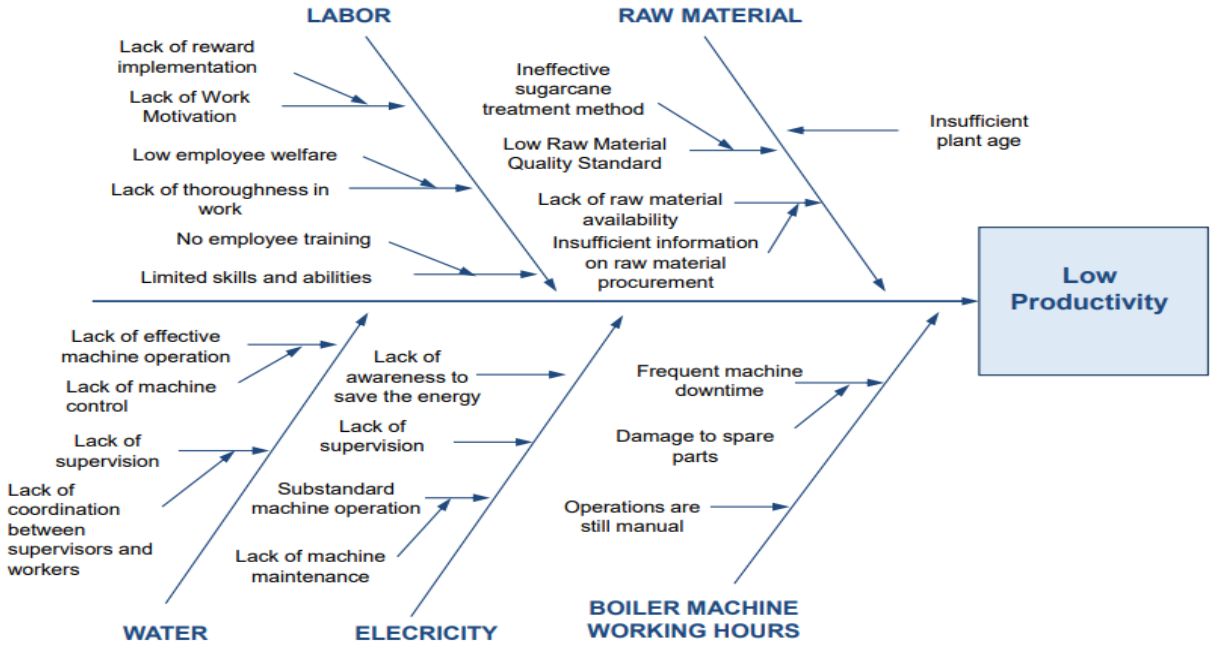

Fig. 2. Fishbone diagram of low productivity factors

Table 6 is a proposed improvement of the low productivity factor for each criterion in Fig. 2, this proposal is expected to increase total and partial productivity.

Table 6. Suggested improvements

Criteria	Factors of Decline	Suggested Improvements
Raw Materials	Low quality standard of raw materials	Cooperation from the company's production and plantation managers to run the process effectively and check the quality of sugarcane as often as possible.
	Insufficient plant age	Coordination between the company's plantation and loggers to pay attention to the age of sugarcane when it will be cut down.
	Lack of raw material availability	Improve cooperative relationships with sugarcane farmers by sharing information on the procurement of quality raw materials.
Labor	Limited skills and abilities	Conduct further evaluation of the skills and abilities of all workers and include job training.
	Lack of work motivation	Improving employee welfare by providing bonuses for employees who excel and providing salaries according to length of service.
	Lack of thoroughness in work	Implement a strict punishment system by giving warning letters to workers who commit violations or irregularities.
Boiler Machine Working Hours	Frequent machine downtime	Scheduling regular service hours and checking before starting the production process.
	Operations are still manual	Replacing the automatic boiler machine and rolling so that workers do not experience fatigue and boredom.
Electricity	Lack of awareness to save the energy	Utilize electricity efficiently by reminding each other if there is a waste of electricity.

Criteria	Factors of Decline	Suggested Improvements
	Lack of supervision of electricity usage.	Supervise the use of electricity as efficiently as possible in an effort to maximize electricity utilization by providing understanding to workers.
	Substandard machine operation	Carry out good maintenance and control of machines, set standard settings, check and repair machines that experience waste.
Water	Lack of effective machine operation	Make efficient use of water by supervising and controlling machines on a regular schedule.
	Lack of supervisory control	Supervise production machinery and workers in the utilization of water so that water can be used as efficiently as possible.

5. CONCLUSION

The purpose of this study is to determine the level of total and partial productivity. The highest total productivity achieved by the company was 750.7 in the 6th period of August and the lowest productivity with a value of 73.8 in the 2nd period of June. While partial productivity is on raw material criteria, the best productivity ratio owned by the company is 6.97. In the labor criteria, the best productivity ratio owned by the company is 1521.86. In the boiler machine working hours criteria, the best productivity ratio owned by the company is 978.91. In the electricity criteria, the best productivity ratio is 3.89. In the water usage criteria, the highest productivity value is 1.83. The second purpose is to be able to provide suggestions for improvement. Proposed improvements can be made to the five criteria, especially labor criteria, namely by conducting further evaluation of the skills and abilities of all workers and including job training. and boiler machine working hours, namely by scheduling regular service hours and checking before starting the production process. In future research, if the company wants to increase productivity targets, the company should add other criteria so that the results are more accurate and comprehensive.

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