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Productivity Analysis Using Objective Matrix (OMAX) and Five Whys Analysis Methods on Rubber Powder Production Line at Pt Tiga Bintang Gautama

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Abstract:- Productivity is an essential element in achieving good production competitiveness. Companies need to know where their productivity levels are. Productivity measurement is instrumental at the management level in doing strategic planning. Objective Matrix (OMAX) is a partial productivity measurement system used to monitor Productivity in each part of the company with productivity criteria according to the existence of that part (Objective). The measurement of Productivity using the OMAX method also involves the AHP method in determining the weight of each ratio. Based on the calculation of Productivity in the period January - August 2020 using the Objective Matrix Method, the results obtained that the productivity values below the average productivity values are the period in March (-15%), April (-39%), May (-1%) and July (-65%) 2020. Then from the results of calculations with OMAX for the period January-August 2020, the achievement scores of each ratio were analyzed using the TLS method and calculated the index of achievement scores against standard productivity scores. The calculation results show that three ratios get a score below the standard. Ratio 1, Ratio 2, and Ratio 5 get an index of achievement score against the standard score of 88% (ratio 1 and 2) and 75% (ratio 5). The five why analysis of the three ratios shows four root causes of the low productivity score of ratio 1, ratio 2, and ratio 5. After further research with the 5W+1H method, it was found that recommendations for improvement that can be done are to increase the supervisory function in production, updating SOPs, conducting job evaluations and training, as well as scheduling machine maintenance.

Keywords:- *Objective Matrix, OMAX, Analytic Hierarchy Process, Traffic Light System, Why why Analysis, 5W + 1H*

I. INTRODUCTION

Research at PT Tiga Bintang Gautama was conducted because of indications of a decline in competitiveness in its production capabilities. During the observation process, it was found that there were issues related to inadequate Productivity. According to data from PT Tiga Bintang Gautama's monthly production data during the January - August 2020 period, it was found that the ongoing production process could not keep up with the demand for orders and targets given by the company.

Table 1 Monthly Production Data of PT Tiga Bintang Gautama for the period January – August 2020 (in kg)

	January	February	March	April	May	June	July	August	Average
Purchase Order	15800	16100	16500	14600	15900	15300	15700	15900	15725
*Production Targets**	16830	17380	17710	18150	16060	17490	16830	17270	17215
Actual Production	13040	13240	12700	12540	12480	12900	12240	11990	12641.3

The data above shows that during the period January - August 2020, the Production line of PT Tiga Bintang Gautama could not achieve the production target for each period. This condition makes the competitiveness of PT Tiga Bintang Gautama very low. Calculation of Productivity is one of the efforts to evaluate the performance of the production line. The Objective Matrix method is used as a calculation method because the object studied is only in the production section. The AHP method is also used as a tool to determine the weight of each ratio. And then be further analyzed to determine the cause of the problem with the 5 Why Analysis method. Which will also be followed up with an analysis of problem fixes using the 5W + 1H method.

II. LITERATURE REVIEW

Understanding Productivity according to Daryanto (2012:41), Productivity is a concept that describes the relationship between results and sources to produce these results. Objective Matrix (OMAX) is a partial productivity measurement system used to observe Productivity in each part of the company with criteria or productivity ratios following the existence of that part (Objective). This method

was developed by James L. Riggs, PE., a professor of the Department of Industrial Engineering at Oregon State University in the 1980s in the United States.

In making the OMAX table, a weighting technique with a reliable method is needed. Wherein in this research, the AHP method is used in weighting the ratio. AHP (Analytic Hierarchy Process) is a method of measurement used to find the ratio scale, both from discrete and continuous pairwise comparisons. Furthermore, to analyze the OMAX table, the TLS method is also used. The Traffic Light System or TLS method is used to facilitate researchers in understanding the achievement of company performance with the help of 3 color categories, namely red, yellow, and green.

After that, the root causes of the problem are analyzed on the ratios that have values below the standard using the Five Whys Analysis method. This method was first introduced and developed by Sakichi Toyoda, and Toyota Motor Corporation of Japan used it to build its Manufacturing Methodology.

III. RESEARCH METHOD

In this study, there are several stages carried out. The first stage is to determine the problem by looking at the phenomena that occur in the research object, then identifying the problem and collecting the data needed for research. In this study, primary data (the results of interviews, FGD, and observations) and secondary data (production data for Jan-Aug 2020) were used. From the data that has been collected, the criteria for calculating the productivity value are determined using the Objective matrix method. The next step is to calculate the ratio value for each period. Then each ratio will also calculate the average and lowest values as a reference in making calculations in the OMAX table. Objective Matrix standard table creation begins by determining the standard weight of each ratio (score 3), namely the average of the values of each ratio in the Jan-Aug 2020 period and the lowest value of each ratio as a value on a score of 0 in the OMAX standard table. Then the company determines the productivity target (score 10) as the target of the productivity achievement of each ratio. The next step is to calculate the interval scale from 0-3 to fill in the score value columns 1 and 2 and calculate the interval scale from 3-10 to fill in the score value column 4 to 9. Then fill in the weighting column by calculating the weight of each ratio using the AHP method.

After the results of the OMAX standard table calculation are complete, the value of each period is entered one by one to find the total productivity score for each period. After that, a performance index is obtained for each period which shows a surplus or minus from the standard performance value. The next stage is to analyze further the ratios that have the most impact on the low value of total Productivity. The TLS method is used by making a score table for each ratio throughout the period studied. Ratios that fall into the red zone throughout the period and have a score below the standard will be analyzed further. From the root cause analysis results using the Five Whys Analysis method, further analysis will be carried out to obtain recommendations for improvement using the 5W+1H method.

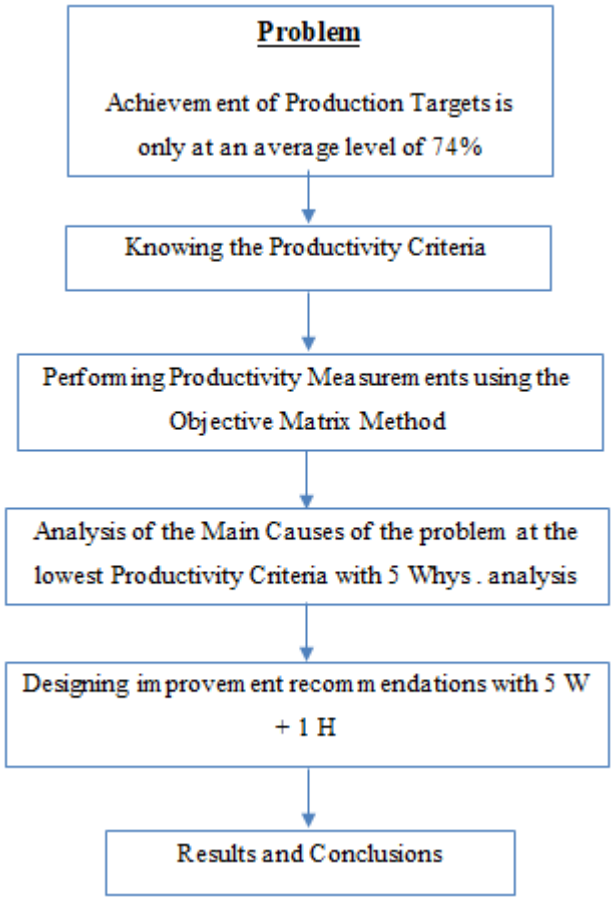

Figure 1 Research Framework

IV. RESULTS AND DISCUSSION

Criteria determination stage

a) Efficiency Criteria

$$\text{Ratio 1} : \frac{\text{Actual Product Quantity (kg)}}{\text{Total Working Time (Hours)}}$$

$$\text{Ratio 2} : \frac{\text{Actual Product Quantity (kg)}}{\text{Total Manpower (People)}}$$

$$\text{Ratio 3} : \frac{\text{Actual Product Quantity (kg)}}{\text{Raw Materials Used (kg)}}$$

$$\text{Ratio 4} : \frac{\text{Actual Product Quantity (kg)}}{\text{Electrical energy (kWH)}}$$

b) Effectiveness Criteria

$$\text{Ratio 5} : \frac{\text{Actual Product Quantity (kg)}}{\text{Production Target (kg)}}$$

$$\text{Ratio 6} : \frac{\text{Defect Product (kg)}}{\text{Actual Product Quantity (kg)}}$$

c) Inferential Criteria

Ratio 7 : $\frac{\text{Number of Absent Workers (people)}}{\text{Total Manpower (people)}}$

Ratio Calculation Stage

After determining the criteria and ratios, then a ratio calculation is made as shown in the table below:

Table 2 Ratio Calculation

2020 period	Efficiency				Effectiveness		Inferential
	Ratio 1 (PA/JWK)	Ratio 2 (PA/JTK)	Ratio 3 (PA/BB)	Ratio 4 (PA/EL)	Ratio 5 (PA/TP)	Ratio 6 (PC/PA)	Ratio 7 (TKA/JTK)
January	4.075	32,600	0.952	3.024	0.775	0.051	0.000
February	4.138	33,100	0.956	2,945	0.762	0.046	0.000
March	3.835	30,529	0.958	2.853	0.717	0.043	0.005
April	4.082	32.656	0.950	2.897	0.691	0.053	0.000
May	4.483	35.455	0.949	2,910	0.777	0.054	0.011
June	4.031	32,250	0.956	2,934	0.738	0.047	0.000
July	3,714	29,423	0.949	2,947	0.727	0.054	0.010
August	4.282	34,063	0.959	2,926	0.694	0.043	0.006
average	4080	32,509	0.954	2,929	0.735	0.049	0.004
Lowest	3,714	29,423	0.949	2.853	0.691	0.043	0.000
Highest	4.483	35.455	0.959	3.024	0.777	0.054	0.011

OMAX standard table creation

Then set the final target (Score 10). The final target to be achieved is based on the policies and capabilities of the company.

Table 3 Target productivity value for each ratio

	Ratio 1 (PA/JWK)	Ratio 2 (PA/JTK)	Ratio 3 (PA/BB)	Ratio 4 (PA/EL)	Ratio 5 (PA/TP)	Ratio 6 (PC/PA)	Ratio 7 (TKA/JTK)
Target	5.136	41,084	0.962	3.046	0.955	0.040	0.000

After that, calculate the interval scale to fill in scores 1 and 2 with the following formula.

Interval Scale : $\frac{\text{Skor 3} - \text{Skor 0}}{3}$

n score : Score n-1 + Interval Scale

Then calculate the interval scale to fill in a score of 4 to 9 with the following formula.

Interval Scale : $\frac{\text{Skor 10} - \text{Skor 4}}{7}$

n score : Score n-1 + Interval Scale

After that, determine the weight of each ratio in the OMAX matrix. In determining the weight of each ratio, the emphasis is on determining the priority value of the criteria, namely comparing which one is more important between one criterion and another. The AHP method was used with the following results.

Table 4 The results of the weighting with the AHP method

	Ratio 1 (PA/JWK)	Ratio 2 (PA/JTK)	Ratio 3 (PA/BB)	Ratio 4 (PA/EL)	Ratio 5 (PA/TP)	Ratio 6 (PC/PA)	Ratio 7 (TKA/JTK)	Weight
Ratio 1 (PA/JWK)	**0.201**	**0.201**	**0.296**	**0.226**	**0.137**	**0.082**	**0.171**	**19%**
Ratio 2 (PA/JTK)	**0.201**	**0.201**	**0.296**	**0.226**	**0.137**	**0.082**	**0.171**	**19%**
Ratio 3 (PA/BB)	**0.067**	**0.067**	**0.099**	**0.338**	**0.137**	**0.082**	**0.171**	**14%**
Ratio 4 (PA/EL)	**0.100**	**0.100**	**0.099**	**0.113**	**0.410**	**0.245**	**0.122**	**17%**
Ratio 5 (PA/TP)	**0.201**	**0.201**	**0.099**	**0.038**	**0.137**	**0.408**	**0.220**	**19%**
Ratio 6 (PC/PA)	**0.201**	**0.201**	**0.099**	**0.038**	**0.027**	**0.082**	**0.122**	**11%**
Ratio 7 (TKA/JTK)	**0.029**	**0.029**	**0.014**	**0.023**	**0.015**	**0.020**	**0.024**	**2%**

After getting the results of the weight of each ratio, then entered into the OMAX standard table.

Table 5 OMAX standard table

Criteria		**Efficiency**				**Effectiveness**		**inferential**
		Ratio 1 (PA/JWK)	**Ratio 2 (PA/JTK)**	**Ratio 3 (PA/BB)**	**Ratio 4 (PA/EL)**	**Ratio 5 (PA/TP)**	**Ratio 6 (PC/PA)**	**Ratio 7 (TKA/JTK)**
Performance								
Target	10	5.136	41,084	0.962	3.046	0.955	0.040	0.0000
	9	4.985	39,859	0.960	3.030	0.923	0.041	0.0006
	8	4,834	38,634	0.959	3.013	0.892	0.042	0.0011
	7	4.683	37,409	0.958	2,996	0.861	0.044	0.0017
	6	4,532	36,184	0.957	2,980	0.829	0.045	0.0022
	5	4.381	34,959	0.956	2,963	0.798	0.046	0.0028
	4	4.231	33,734	0.955	2,946	0.766	0.047	0.0034
Standard	3	4080	32,509	0.954	2,929	0.735	0.049	0.0039
	2	3.958	31,481	0.952	2,904	0.720	0.050	0.0063
	1	3.836	30,452	0.950	2.879	0.706	0.052	0.0086
	0	3,714	29,423	0.949	2.853	0.691	0.054	0.0110
Score								
Weight %		19	19	14	17	19	11	2
Mark								
Performance indicators								

Calculating Performance Value and Productivity Index

The results of the calculation of the ratio value in each period are entered into the OMAX standard table to find out the achievement of the score for each ratio. The following is an example of calculating the ratio score for the January 2020 period.

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Table 6 OMAX table for January 2020 period

Criteria		Efficiency				Effectiveness		inferential
		Ratio 1 (PA/JWK)	Ratio 2 (PA/JTK)	Ratio 3 (PA/BB)	Ratio 4 (PA/EL)	Ratio 5 (PA/TP)	Ratio 6 (PC/PA)	Ratio 7 (TKA/JTK)
Performance		**4.08**	**32.60**	**0.952**	**3.02**	**0.77**	**0.051**	**0.0000**
Target	10	5.14	41.08	0.962	3.05	0.95	0.040	0.0000
	9	4.98	39.86	0.960	3.03	0.92	0.041	0.0006
	8	4.83	38.63	0.959	3.01	0.89	0.042	0.0011
	7	4.68	37.41	0.958	3.00	0.86	0.044	0.0017
	6	4.53	36.18	0.957	2.98	0.83	0.045	0.0022
	5	4.38	34.96	0.956	2.96	0.80	0.046	0.0028
	4	4.23	33.73	0.955	2.95	0.77	0.047	0.0034
Standard	3	4.08	32.51	0.954	2.93	0.74	0.049	0.0039
	2	3.96	31.48	0.952	2.90	0.72	0.050	0.0063
	1	3.84	30.45	0.950	2.88	0.71	0.052	0.0086
	0	3.71	29.42	0.949	2.85	0.69	0.054	0.0110
Score		3	3	2	8	4	1	10
Weight %		19	19	14	17	19	11	2
Mark		57	57	28	136	76	11	20
Performance indicators		**385**						

Based on the results of the productivity calculation using the Objective Matrix method, the productivity value for the January-Aug 2020 period is obtained. Then the productivity index is calculated by comparing the performance indicators for each period with the basic period.

Table 7 Productivity index

2020 period	Performance indicators	Basic period	Productivity index
January	385	300	28%
February	367	300	22%
March	255	300	-15%
April	182	300	-39%
May	297	300	-1%
June	318	300	6%
July	106	300	-65%
August	396	300	32%

The table above shows that from the calculations using the OMAX method, there was a decrease in below-standard Productivity in March, April, May, and July 2020. A negative value indicates it in the productivity index.

Determining Low-Performance Ratio

The calculation of the OMAX method provides data visualization about the Productivity of each period. But in addition to being able to find out the cause of the decline in productivity, it is necessary to analyze the achievement of scores on each ratio in the January - August 2020 period. And to simplify the analysis, the Traffic Light System method is also used, which gives different colors according to the pre-determined TLS range. The following are the results of the analysis of the achievement of each ratio score.

Table 8 Traffic Light System

2020 period	Efficiency				Effectiveness		inferential
	Ratio 1 (PA/JWK)	Ratio 2 (PA/JTK)	Ratio 3 (PA/BB)	Ratio 4 (PA/EL)	Ratio 5 (PA/TP)	Ratio 6 (PC/PA)	Ratio 7 (TKA/JTK)
January	3	3	2	8	4	1	10
February	3	3	5	3	3	5	10
March	1	1	7	0	2	7	2
April	3	3	1	2	0	0	10
May	5	5	0	1	4	0	7
June	2	2	5	3	3	4	10
July	0	0	0	4	2	0	0
August	4	4	8	3	0	7	2
Total	21	21	28	24	18	24	51
Weight %	**19**	**19**	**14**	**17**	**19**	**11**	**2**
Total Score	399	399	392	408	342	264	102
basic score	456	456	336	408	456	264	48
Percentage achievement	88%	88%	117%	100%	75%	100%	213%

With the help of the TLS method in the table above, it is easy to identify the ratios that require immediate improvement. Among them are ratio 1, ratio 2, and ratio 5, where the three ratios have no scores in the green zone.

The percentage of achievement of the total score of each ratio to the basic score of each ratio also shows that the three ratios have below standard achievements. Thus, these three ratios will be analyzed for causes and recommendations for improvement.

Root Cause Analysis (Five Whys Analysis)

Of the three ratios that have scores below the standard, root cause analysis uses the 5 Whys Analysis method.

Table 9 *5 Whys Analysis*

Items	Why 1	Why 2	Why 3	Why 4	Why 5	Root Cause
Ratio 1	The efficiency of Working Hours to Total Actual Production is low	Inefficient use of working time	Inefficient way of working	A lot of time is wasted on unnecessary activities	The Production Supervisor does not carry out the supervisory function in a strict and disciplined manner.	The Production Supervisor does not carry out the supervisory function in a strict and disciplined manner.
Ratio 2	The efficiency of the Number of Labor against the amount of Actual Production is low	Cooperation in work is not efficient	Lack of workers understanding of efficient work	SOP is not going well	There is no written SOP that is clear and easy to understand	There is no written SOP that is clear and easy to understand
Ratio 5	Actual Production Effectiveness against Low Production Target	Low Actual Production Achievement	Unproductive workers	No job evaluation and training		No job evaluation and training
			The machine cannot reach the required production capacity	*Maintenance* machine not noticed		*Maintenance* machine not noticed

Improvement Recommendation (5W+1H)

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After analyzing the root cause of the low productivity value of ratio 1, ratio 2, and ratio 5. It was found that there were four root causes of the problem. From the four root cause points, an analysis of the repair of the problem was carried out using the 5W + 1H method. The following table is an analysis of improvements using the 5W + 1H method.

Table 10 5W+1H

Items	Root Cause	What	Why	Where	when	Who	How
Ratio 1	The Production Supervisor does not carry out the supervisory function in a strict and disciplined manner.	The Production Supervisor does not carry out the supervisory role in a tough and disciplined manner.	The production supervisor does not understand his obligations in carrying out the supervisory function.	Dep. Production	2021 period	Spv production	Carry out the supervisory function properly so that production continues to run optimally.
Ratio 2	There is no written SOP that is clearly and easily understood.	There is no written SOP that is clearly and easily understood.	SOP has never been updated in the last few years and has not made posters or pamphlets that the operator can read at any time.	Dep. Production	2021 period	Kep Production	It updates the SOP with a language that is easier to understand and makes a printed version to be pasted in the production area.
Ratio 5	There is no job evaluation and training.	There is no job evaluation and training.	Workers are only trained during their training period, which is the first month.	Dep. Production	2021 period	Head of the production	They are conducting job evaluations and training on effective and efficient work methods and providing Industrial K3.
	The maintenance engine is not noticed.	Machine maintenance is not considered.	Because not realizing that downtime and decreased machine performance make a significant impact on Productivity.	Dep. Production	2021 period	Head of the production	Perform the most effective and efficient maintenance scheduling on the current production scheme.

V. CONCLUSION AND SUGGESTION

- **Conclusion**

Based on the calculations and analysis of production line productivity at PT Tiga Bintang Gautama in this study, the following conclusions were obtained.

1. Based on the calculation of Productivity in the period January - August 2020 using the Objective Matrix Method, the results obtained that productivity values below the average productivity values are the periods in March (-15%), April (-39%), May (-1%) and July (-65 %) 2020.
2. From the results of calculations with OMAX for the period January-August 2020, the achievement of scores for each ratio using the TLS method was analyzed, and the index of achievement scores against standard productivity scores was calculated. The results of the analysis show that three ratios get scores below the standard. Ratio 1, Ratio 2, and Ratio 5 get a score achievement index to the standard score of 88% (ratio 1 and 2) and 75% (ratio 5).
3. Of the three ratios that get a total score below the standard total score, a cause analysis is carried out using the 5 Whys Analysis method. The root cause of the three ratios is obtained as follows.

a. Ratio 1 - The Production Supervisor does not carry out the supervisory function strictly and is disciplined.
b. Ratio 2 - There is no written SOP that is clearly and easily understood.
c. Ratio 5 - No job evaluation and training.
d. Ratio 5 - Machine maintenance is not noticed.

And from the four root causes, The improvement recommendation analysis was carried out using the 5W + 1H method with the following recommendations for improvement.

a. We are maximizing the Supervisory function in the organizational system.
b. It updates the SOP with a language that is easier to understand and makes a printed version to be pasted in the production area.
c. We are conducting job evaluations and training on effective and efficient work methods and providing Industrial K3.

d. Perform the most effective and efficient maintenance scheduling on the current production scheme.

- **Suggestion**

Suggestions that can be given after this research are both practical and academic. The following are suggestions that researchers can provide.

1. Conduct further research on machine maintenance procedures to get the correct method and schedule to optimize machine use.
2. Make improvements to the work system and carry out periodic work evaluations. Also considered to be able to provide job training and job understanding to operators

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