PRODUCTIVITY ANALYSIS OF ERGONOMIC CHAIR FOR OPERATOR POND MACHINE

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ABSTRACT

There is a previous study analyzing the design of ergonomic chairs for pond machine operators, where the analysis uses the RULA method manually, Based on the results of data processing with the RULA method, it can be concluded that the posture of the ring making operator (washer) operator with a slightly bent body position has a score value 5, and the chair design based on the redesign of the pond engine operator chair shows that the final result is 3. (Mukhtar, 2018) In this study, a productivity analysis is carried out to measure the level of chair productivity by considering several aspects of work activities, The method used is the Objective Matrix (OMAX) and the determination of the score from the performance appraisal using the Analytical Hierarchy Process (AHP) method. The results obtained are Productivity increased from before, because it is still in the range of 3-10 (based on the matrix table the score 3-5 is good enough, 6-8 good and 9-10 very good) and the lowest values shown in this table are 3 and 4 Based on the scores, the scores are still quite good. But there still must be improvement. Overall the level of productivity has increased compared to before. But there are still fluctuating data. This is due to the lack of uniformity in the ability of the operator to run the pond engine in washer production.

Keyword : Productivity, Ergonomics Chair, Pond Machine

1. INTRODUCTION

Every industry, both large and small, wants to maintain its business to survive in the face of competitive competition, companies must improve internally, one of them is by increasing productivity. Because this will make the company grow. Productivity is a picture of the company's achievements (Agustin & Riana, 2011) which is able to

provide an overview of the relationship of output and input used to produce output (Zanuar, 2014).

The obstacle of the company in increasing productivity on the production floor is generally influenced by the inappropriate use of resources during production activities. For this reason, productivity measurements are needed on the production floor (Avianda et al., 2014). By measuring this productivity the company is able to find out the level of productivity that has been achieved and can be used as a foundation for the company's future planning (Zanuar, 2014). So, companies can evaluate the factors that affect changes in productivity of the company (Pangaula et al., 2015)

This increase in productivity is closely related to efforts to improve the level of a country's economy and to strengthen Indonesia's position in increasingly fierce world trade competition. On a company scale, it is hoped that there will be efforts to increase productivity, which in turn can support national productivity

Productivity measurement is done by taking into account the condition of the company, so that the size obtained is able to provide a clear picture of the level of productivity of the company (Zanuar, 2014). The inefficient and effective use of raw material, labor, energy, and machine resources during production activities encourages companies to increase productivity. Therefore companies need to take productivity measurements to find out the dominant factors that influence productivity.

In previous studies analyzing the design of ergonomic chairs for pond machine operators, where the analysis using the RULA method manually, Based on the results of data processing with the RULA method, it can be concluded that the posture of the ring making operator (washer) operator with a slightly bent body position has a score value 5, and the

chair design based on the redesign of the pond engine operator chair shows that the final result is 3. (Mukhtar, 2018)

The purpose of this research is to measure the level of productivity of the design of ergonomic chair designs used by pond machine operators. Considering the important role of the production process activities carried out by pond machine workers in the metal industry, where labor plays a dominant role, it should be done study to analyze and evaluate work postures.

In this research, productivity analysis was carried out to measure the level of chair productivity by considering several aspects of work activities, the method used was Objective Matrix (OMAX). The productivity measurement method used is the Objective Matrix (OMAX) method and for determining the score of the performance appraisal using the Analytical Hierarchy Process (AHP) method. In this method provides an overview of the state of company productivity. Raw material is one of the important components of input which acts as a basic material in washer production. And also labor is one of the input components that acts as the manager of the management system and with the machine runs the production process.

Based on these problems, it is necessary to measure how effective and efficient the washer component production process uses an ergonomic chair for the pond machine operator.

2. METOD

Data processing using the method developed by James L. Riggs has the following stages (Riggs, 1986 referred to in the Balkans, 2010):

- Determine measurement objectives
- Determine measurement criteria
- Determine the performance ratio

Performance is the level of productivity which is the ratio of each measurement criterion. Performance value is obtained by dividing the ratio of inputs with outputs on each criterion.

- Determine the target (Faridz et al., 2010).

Determine the Final Target Target (Score 10) The value of the score of 10 is obtained from the BKA (Upper Control Limit) which is the maximum productivity limit that

the company might achieve from each productivity criterion. The BKA, DA (Degree of Accuracy), and CL (Confident Level) formulas are:

$$BKA = \mu + k \cdot \sigma \dots \dots \dots (1)$$

$$DA = DA = \mu / \times 100 \dots \dots \dots (2)$$

$$CL = 100\% - DA. \dots \dots \dots (3)$$

Information:

BKA: Upper Control Limit.

μ : The average of each criterion measured.

σ : Standard Deviation.

k: Constants.

k: 1, if the confidence level (CL) lies at 0%
CL 68%.

k: 2, if the confidence level (CL) lies at 68%
<CL 95%.

k: 3, if the confidence level (CL) lies at 95%
<CL 99.7%.

Determining Short-Term Goals (Score

3) The value on the score 3 is the value of productivity that has been achieved so far. The score on score 3 is obtained by averaging the radio values for each criterion. The formula to calculate the average is:

$$\mu = 1 / (n - (i = 1) ^ n \text{ Xi}) \dots \dots \dots (4)$$

Information :

μ : The average of each criterion measured for 3 months

n: amount of data

Xi: The ratio of each criterion

Determine the Lowest Productivity Value (Score 0) The value on the score 0 is obtained from the BKB (Lower Control Limit) which is the minimum productivity limit that may be achieved by the company. The BKB formula is:

$$BKA = \mu - k \cdot \sigma \dots \dots \dots (5)$$

Determine realistic productivity values (Score 1-2 and Score 4-9) Realistic productivity values are values that might be achieved before the final goal. Scores 1-2 and scores 4-9 are obtained from interpolation. The interpolation formula used is (Balkan, 2010):

$$h \quad u-s = \frac{s \quad s-s \quad u}{s-u} \dots \dots (6)$$

$$h \quad s-1 = \frac{s \quad 1-s \quad s}{1-s} \dots \dots (7)$$

Determining the value of criteria weights Determining the weight of each criterion is emphasized in determining the priority value of criteria by comparing which is more important between criteria. To make it

easier to determine priorities, it is necessary to make a conversion table of priority statements

into numbers. Following is a table of priority criteria used (Agustina & Riana, 2011).

Table 1. Priority Scale Criteria

Value	Value Priority Level
1	CRITERIA 1 is as important as CRITERIA 2
2	CRITERIA 1 is slightly more important than CRITERIA 2
5	CRITERIA 1 is more important than CRITERIA 2
7	CRITERIA 1 is very important compared to CRITERIA 2
9	9 CRITERIA 1 is far more important than CRITERIA 2
3,4,6,8	CRITERIA 1 *) middle value

3. RESULT

a. Determine research objectives

The purpose of this study was to determine the level of productivity of workers / operators of pond machines before and after using ergonomic chairs using the OMAX method.

b. Establish Criteria

The criteria to be measured are 4 criteria:

- 1) Criteria 1 is the amount of material used per hour.

- 2) Criteria 2 is the number of defective rings

- 3) Criteria 3 is the amount of operator productive time

These three criteria are the input in this study and the output is the amount of ring / washer production without defects. The data is obtained from historical data of the engine operator when using ergonomic chairs in July 2019 - September 2019. Input and output data can be seen in Table 2.

Table 2 Input and output data

Operator	Input			Output
	Material used (Kg)	washer defect (Pcs)	Productive time (Jam)	washer without defect (Kg)
A	87.32	183.21	4.55	35.51
B	85.43	207.98	3.42	38.42
C	75.78	140.12	5.12	28.89
D	86.19	190.38	4.23	39.54
E	82.45	126.93	3.57	34.33
F	78.65	118.22	5.3	29.24
G	82.67	201.83	4.32	35.43
H	90.31	198.94	5.43	42.11

c. Performance ratio

Performance values indicate the number of products produced from

each unit of resource used. Values are calculated by output / input.

Performance values can be seen in the following.

Table 4.
Table 3 Value of Performance Ratio

Input			
Operator	Material used (Kg)	washer defect (Pcs)	Productive time (Jam)
A	28.093	13.390	539.147
B	33.248	13.657	662.093
C	22.723	12.289	336.324
D	36.229	16.402	738.189
E	31.926	20.738	563.668
F	26.983	17.952	423.601
G	33.343	13.657	638.063
H	38.070	17.282	633.169
Rata- rata	31.33	15.67	566.78
StandarDeviasi	5.08	2.90	132.20

d. Target

1) Final Target Target (Score 10)

Criteria for Material Use

$$= 5.08; \mu = 31.33$$

$$\text{Accuracy Level DA} = \mu \times 100\%$$

$$\text{DA} = 5.08 / 31.33 \times 100\% = 0.163$$

$$\text{Confidence level CL} = 100\% - \text{DA} = 0.837$$

$\text{UCL} = \mu + k$. (k = 2. Because CL lies at 68% < CL 95%.)

$$\text{UCL} = 31.33 + 2 \times 5.33 = 41.49$$

Score 10 is the productivity value expected by the company in this case UKM. So to find out all the final targets on each input criteria used, it can be seen in the following table 4.

Table 4 final targets for each input criterion

Input			
Operator	Material used (Kg)	washer defect (Pcs)	Productive time (Jam)
DA	0.162	0.184	0.233
CL	0.837	0.815	0.766
UCL	41.49	21.46	831.18

2) Short-term target (Score 3)

Criteria of material used

$$\mu = \frac{1}{8} \sum_{i=1}^8 87.32 + \dots + 90.31 = 31.33$$

Criteria of washer defect

$$\mu = \frac{1}{8} \sum_{i=1}^8 183.21 + \dots + 198.94 = 15.67$$

Criteria of productive time

$$\mu = \frac{1}{8} \sum_{i=1}^8 4.55 + \dots + 5.43 = 566.78$$

3) Target sasaranTerburuk (Skor 0)

Criteria of material used

$$= 5.08 ; \mu = 31.33$$

$$LCL= UCL= \mu - k . \quad (k= 2. \text{ Beacause}$$

CL lies on $68\% < CL \leq 95\%$.)

$$LCL= UCL= \mu - k . \quad = 31.33 - (2 \times 5.08) = 21.15$$

So as to find out all the worst targets in each input criteria used, it can be seen in the following table 5.

Table 5 Worst Target

Input			
Operator	Material used (Kg)	washer defect (Pcs)	Productive time (Jam)
DA	0.162298	0.184886359	0.233247
CL	0.837702	0.815113641	0.766753
LCL	21.15835	9.876211073	302.3819

e. Realistic Productivity Rating (Score 1-2 and Score 4-9)

Criteria for material use

The interval between the score is 0 to 3

$$\text{Interval } 0-3 = (UCL-LCL)/3 = (41.49-21.158)/3 = 6.78$$

Interval between the score 3 to 10

$$\text{Interval } 3-10 = (UCL-LCL)/7 = (41.49-21.158)/7 = 4.96$$

Table 6 Recap of realistic productivity values for all criteria

Input			
Operator	Material used (Kg)	washer defect (Pcs)	Productive time (Jam)
DA	0.16	0.18	0.23
CL	0.84	0.82	0.77
UCL	41.50	21.47	831.18
LCL	21.16	9.88	302.38
skor 0-3	6.78	3.86	176.27
skor 3-10	4.96	2.51	93.56

f. Criteria Weight Value

Determination of criteria weights by comparing each criterion is shown in table 7 below.

Table 7. Comparison of priorities for each criterion

	Material used (Kg)	washer defect (Pcs)	washer defect (Pcs)
Material used (Kg)	1	2	3
washer defect (Pcs)	1/2	1	1/5
washer defect (Pcs)	1/3	5	1

Based on the results of weighting in table 4.6 the next step is to determine the weighting that ranges from 0-1 and the total weight of each column is 1. The weight calculation is

by dividing the numbers in each cell by adding all the numbers in one column. For example cell 1 = $1 / (1 + 2 + 7) = 0.1$.

Table 8. Value comparison of priority of each criterion

	Material used (Kg)	washer defect (Pcs)	washer defect (Pcs)
Material used (Kg)	0.545	0.250	0.714
washer defect (Pcs)	0.273	0.125	0.048
washer defect (Pcs)	0.182	0.625	0.238

Then look for the weights of each criterion by adding up the weights in one row in table 9 with the number of columns. So each criterion is:

Criteria for material use = $(0.545 + 0.250 + 0.714) / 3 = 0.504$

Criteria for ring / washer defect = $(0.273 + 0.125 + 0.048) / 3 = 0.148$

Criteria for productive time = $(0.182 + 0.625 + 0.238) / 3 = 0.348$

The result of all weighting is 1 (100%)

After doing the steps for making the initial matrix. Next is to do the weighting of the four criteria that are grouped on each individual / worker, and the results of the weighting can be seen in the following table 4.8.

Table 9 results of weighting of workers A

	Material used (Kg)	washer defect (Pcs)	washer defect (Pcs)
Performance	28.09	13.39	539.147
10	41.49	21.47	831.18
9	36.53	18.96	737.62
8	31.57	16.45	644.06
7	26.61	13.94	550.50
6	21.65	11.43	456.94
5	16.69	8.92	363.38
4	11.73	6.41	269.82
3	31.33	15.67	566.78
2	24.55	11.81	363.78
1	17.77	7.95	187.51
0	21.16	9.88	302.38
Score	7	2	6
Weight	0.504	0.148	0.348
Value	3.528	0.296	2.088
Total		5.912	

Table 10 Work achievements of each operator

Operator	Work achievement
A	3.592
B	9.208
C	4.132
D	9.2
E	7.06
F	4.932
G	8.356
H	9.156

Figure 1 Graphic productivity before using tools

Then after doing the calculations for all weights to the achievement of performance

for each operator. Then compared between before using the operator seat.

Figure 2 comparison of the productivity of the use of a chair

Based on the analysis of data retrieval that has been processed using the OMAX method, the following data are obtained for the

productivity of the pond engine operator after using an ergonomic chair.

Table 11 results of weighting productivity after using an ergonomic chair

Operator	Material used (Kg)	washer defect (Pcs)	washer defect (Pcs)
A	7	10	6
B	9	4	3
C	8	6	8
D	10	8	9
E	4	9	10
F	6	7	6
G	7	3	8
Total	51	47	50

Based on the above table, in general it can be concluded that productivity increased from before, because it is still in the range of 3-10 (based on the matrix table the score 3-5 is good enough, 6-8 good and 9-10 very good) and the lowest value is shown in these tables are 3 and 4. Based on the scores the scores are still quite good. But there still must be improvement. A value of 3 is obtained for operator G for the defective ring / washer criterion and for operator B for the Earning Time criteria. A set of 4 scores was obtained from operator E on the material used criteria and on operator B on the defective ring / washer criterion.

4. CONCLUSION

Productivity increased from before, because it is still in the range of 3-10 (based on the matrix table the scores are quite good 3-5, 6-8 good and 9-10 very good) and the lowest values shown in this table are 3 and 4. Based on the score scores it is still quite good. But there still must be improvement. A value of 3 is obtained for operator G for the defective ring / washer criterion and for operator B for the Earning Time criteria. Whereas the score 4 is obtained from the E operator on the used material criteria and on the B operator on the defective ring / washer criteria. Overall the level of productivity has increased compared to before. But there are still fluctuating data. This is due to the lack of uniformity in the ability of the operator to run the pond engine in washer production.

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3. RESULT

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1) Final Target Target (Score 10)

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2) Short-term target (Score 3)

Criteria of material used

$$\mu = \frac{1}{8} \sum_{i=1}^8 87.32 + \dots + 90.31 = 31.33$$

Criteria of washer defect

$$\mu = \frac{1}{8} \sum_{i=1}^8 183.21 + \dots + 198.94 = 15.67$$

Criteria of productive time

$$\mu = \frac{1}{8} \sum_{i=1}^8 4.55 + \dots + 5.43 = 566.78$$

3) Target sasaranTerburuk (Skor 0)

Criteria of material used

$$= 5.08 ; \mu = 31.33$$

LCL= UCL= $\mu - k \cdot$ (k= 2. Beacause CL lies on 68% < CL 95%.)

$$LCL= UCL= \mu - k \cdot = 31.33 - (2 \times 5.08) = 21.15$$

So as to find out all the worst targets in each input criteria used, it can be seen in the following table 5.

Table 5 Worst Target

Input			
Operator	Material used (Kg)	washer defect (Pcs)	Productive time (Jam)
DA	0.162298	0.184886359	0.233247
CL	0.837702	0.815113641	0.766753
LCL	21.15835	9.876211073	302.3819

e. Realistic Productivity Rating (Score 1-2 and Score 4-9)

Criteria for material use

The interval between the score is 0 to 3

$$\text{Interval}0-3=(UCL-LCL)/3=(41.49-21.158)/3=6.78$$

Intervalbetween thescore3to 10

$$\text{Interval}3-10=(UCL-LCL)/7=(41.49-21.158)/7=4.96$$

Table 6 Recap of realistic productivity values for all criteria

Input			
Operator	Material used (Kg)	washer defect (Pcs)	Productive time (Jam)
DA	0.16	0.18	0.23
CL	0.84	0.82	0.77
UCL	41.50	21.47	831.18
LCL	21.16	9.88	302.38
skor 0-3	6.78	3.86	176.27
skor 3-10	4.96	2.51	93.56

f. Criteria Weight Value

Determination of criteria weights by comparing each criterion is shown in table 7 below.

Table 7. Comparison of priorities for each criterion

	Material used (Kg)	washer defect (Pcs)	washer defect (Pcs)
Material used (Kg)	1	2	3
washer defect (Pcs)	1/2	1	1/5
washer defect (Pcs)	1/3	5	1

Based on the results of weighting in table 4.6 the next step is to determine the weighting that ranges from 0-1 and the total weight of each column is 1. The weight calculation is

by dividing the numbers in each cell by adding all the numbers in one column. For example cell 1 = $1 / (1 + 2 + 7) = 0.1$.

Table 8. Value comparison of priority of each criterion

	Material used (Kg)	washer defect (Pcs)	washer defect (Pcs)
Material used (Kg)	0.545	0.250	0.714
washer defect (Pcs)	0.273	0.125	0.048
washer defect (Pcs)	0.182	0.625	0.238

Then look for the weights of each criterion by adding up the weights in one row in table 9 with the number of columns. So each criterion is:

Criteria for material use = $(0.545 + 0.250 + 0.714) / 3 = 0.504$

Criteria for ring / washer defect = $(0.273 + 0.125 + 0.048) / 3 = 0.148$

Criteria for productive time = $(0.182 + 0.625 + 0.238) / 3 = 0.348$

The result of all weighting is 1 (100%)

After doing the steps for making the initial matrix. Next is to do the weighting of the four criteria that are grouped on each individual / worker, and the results of the weighting can be seen in the following table 4.8.

Table 9 results of weighting of workers A

	Material used (Kg)	washer defect (Pcs)	washer defect (Pcs)
Performance	28.09	13.39	539.147
10	41.49	21.47	831.18
9	36.53	18.96	737.62
8	31.57	16.45	644.06
7	26.61	13.94	550.50
6	21.65	11.43	456.94
5	16.69	8.92	363.38
4	11.73	6.41	269.82
3	31.33	15.67	566.78
2	24.55	11.81	363.78
1	17.77	7.95	187.51
0	21.16	9.88	302.38
Score	7	2	6
Weight	0.504	0.148	0.348
Value	3.528	0.296	2.088
Total		5.912	

Table 10 Work achievements of each operator

Operator	Work achievement
A	3.592
B	9.208
C	4.132
D	9.2
E	7.06
F	4.932
G	8.356
H	9.156

Figure 1 Graphic productivity before using tools

Then after doing the calculations for all weights to the achievement of performance

for each operator. Then compared between before using the operator seat.

Figure 2 comparison of the productivity of the use of a chair

Based on the analysis of data retrieval that has been processed using the OMAX method, the following data are obtained for the

productivity of the pond engine operator after using an ergonomic chair.

Table 11 results of weighting productivity after using an ergonomic chair

Operator	Material used (Kg)	washer defect (Pcs)	washer defect (Pcs)
A	7	10	6
B	9	4	3
C	8	6	8
D	10	8	9
E	4	9	10
F	6	7	6
G	7	3	8
Total	51	47	50

Based on the above table, in general it can be concluded that productivity increased from before, because it is still in the range of 3-10 (based on the matrix table the score 3-5 is good enough, 6-8 good and 9-10 very good) and the lowest value is shown in these tables are 3 and 4. Based on the scores the scores are still quite good. But there still must be improvement. A value of 3 is obtained for operator G for the defective ring / washer criterion and for operator B for the Earning Time criteria. A set of 4 scores was obtained from operator E on the material used criteria and on operator B on the defective ring / washer criterion.

4. CONCLUSION

Productivity increased from before, because it is still in the range of 3-10 (based on the matrix table the scores are quite good 3-5, 6-8 good and 9-10 very good) and the lowest values shown in this table are 3 and 4. Based on the score scores it is still quite good. But there still must be improvement. A value of 3 is obtained for operator G for the defective ring / washer criterion and for operator B for the Earning Time criteria. Whereas the score 4 is obtained from the E operator on the used material criteria and on the B operator on the defective ring / washer criteria. Overall the level of productivity has increased compared to before. But there are still fluctuating data. This is due to the lack of uniformity in the ability of the operator to run the pond engine in washer production.

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