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ANALYSIS OF PHYSICAL AND MENTAL WORKLOAD ON FINISHING OPERATOR USING NASA TLX METHOD AND WORK SAMPLING AT PT. PASSION ABADI KORPORA

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Abstract.
PT. Passion Abadi Korpora as one of the producers of the jewelry retail industry, every company must pay attention to the balance of the workload of its employees. PT. Passion Abadi Korpora has many departments in it, although it is not easy to do but the company must be able to balance the two burdens. One of the departments that also has a workload imbalance is the finishing production department. To measure the workload, you can use the NASA-TLX method on mental workloads, for physical workloads using the Work Sampling method which then produces the optimal amount of productivity. There are six indicators in the NASA-TLX method, namely mental needs, physical needs, time requirements, work performance, frustration levels, and physical and mental effort. In the finishing production department there are 20% for work performance indicators, 7% for time requirements indicators, 20% for physical and mental effort indicators, 20% for mental needs indicators, and 13% each for indicators of physical needs and frustration levels. Based on the calculation results, the highest productive working hours were obtained, the first being Nurman with 146 hours/month, followed by Rahma Purnomo with 145 hours/month, and Dwi Rian S, Andri Andrianto with 144 hours/month. The results of these calculations can be caused by the heavy workload of operators who are rarely found unemployed when observing for 5 working days. There are 3 (three) factors that cause mental workload, namely lack of training and understanding of work for operators, poor time management and inadequate work environment. The most dominant thing felt by finishing operators on the production floor is the demands of work from a human point of view. Because the work demands given by the company are evenly distributed between new employees and old employees. For the old employees, it is suggested to use headphones so as not to disturb the concentration of the new employees. Furthermore, the proposed improvement that can be made by the company is to design a product, namely a box that can be used in finishing work so that the gold flakes that are filed or sanded do not scatter on the table and can be collected for smelting so that there is a retrun which can reduce the loss of grams of gold. The most dominant thing felt by finishing operators on the production floor is the demands of work from a human point of view. Because the work demands given by the company are evenly distributed between new employees and old employees. For the old employees, it is suggested to use headphones so as not to disturb the concentration of the new employees. Furthermore, the proposed improvement that can be made by the company is to design a product, namely a box that can be used in finishing work so that the gold flakes that are filed or sanded do not scatter on the table and can be collected for smelting so that there is a retrun which can reduce the loss of grams of gold. The most dominant thing felt by finishing operators on the production floor is the demands of work from a human point of view. Because the work demands given by the company are evenly distributed between new employees and old employees. For the old employees, it is suggested to use headphones so as not to disturb the concentration of the new employees. Furthermore, the proposed improvement that can be made by the company is to design a product, namely a box that can be used in finishing work so that the gold flakes that are filed or sanded do not scatter on the table and can be collected for smelting so that there is a retrun which can reduce the loss of grams of gold. Because the work demands given by the company are evenly distributed between new employees and old employees. For the old employees, it is suggested to use headphones so as not to disturb the concentration of the new employees. Furthermore, the proposed improvement that can be made by the company is to design a product, namely a box that can be used in finishing work so that gold flakes that are filed or sanded do not scatter on the table and can be collected for smelting so that there is a retrun which can reduce the loss of grams of gold. Because the work demands given by the company are evenly distributed between new employees and old employees. For the old employees, it is suggested to use headphones so as not to disturb the concentration of the new employees. Furthermore, the proposed improvement that can be made by the company is to design a product, namely a box that can be used in finishing work so that the gold flakes that are filed or sanded do not scatter on the table and can be collected for smelting so that there is a retrun which can reduce the loss of grams of gold.

Keywords: *NASA – TLX, Sampling Test, Physical Workload, Mental Workload, Productivity.*

Introduction

Humans are one of the important components in organizations and industrial activities (both those that produce products or services). Human activities can be classified into two main components, namely physical work is a workload

that involves muscle work, and mental work is a workload that involves the brain (Pracinasari, 2013). This physical and mental activity can have consequences, namely the emergence of workloads.

Fatigue is one of the causes of decreased employee productivity. Fatigue can occur due to the workload imposed on the operator. The workload received by a person must be appropriate and balanced with the physical and mental abilities of the workers who receive the workload so that fatigue does not occur. (Hart in Ramadan, et al, TT). The workload imposed on a person can occur in three conditions, First, the workload according to standards. Second, the workload is too high. Third, the workload is too low.

PT. Passion Abadi Korpora is a retail company engaged in diamond jewelry retail which is divided into three trademarks, namely Passion Jewelry, Passion Prive, and Diamond & Co. To make a jewelry product, you need to go through several production processes that must be carried out starting from 2D Design, Jewel CAD 3D, Casting, Finishing, Polishing and Diamond Installation. Based on the 4M+E analysis, the man factor is the main problem causing the workload because the operator feels symptoms of excessive fatigue, causing feelings of sluggishness, sleepiness, dizziness, lack of accuracy, lack of concentration, slow response and loss of enthusiasm for work in the presence of this fatigue. productivity of employees that affect the finishing process. In this process there is a decrease in gram weight before and after finishing. Based on the finishing productivity data, there are 5 operators who have a total value of gold gram losses exceeding the rate provided by the company. For operators who have a gram loss value that exceeds the rate, punishment will be given. So that the finishing production operator does not get punishment, therefore it must produce optimal output.

To overcome this problem, it is necessary to conduct a study to determine the mental workload and productivity of the operator's work on the production floor in the finishing section, namely the measurement of physical work is carried out with a work sampling approach. The work sampling method is an approach method used to measure productivity. The work sampling method can also be used to determine the operator's productive and non-productive activities, while the mental workload measurement uses the NASA-TLX workload analysis method.

Library Review

Workload

Workload is one aspect that must be considered by every company, because workload can have an effect on employee productivity results. Workload as a concept that arises due to limited capacity in processing information.

Nasa – TLX

NASA-TLX (National Aeronautics And Space Administration Task Load Index) is a method that evaluates subjective workloads, where workers are asked to give their opinion on the work being carried out. In the NASA-TLX method, workers are asked to rate between 0 and 100 on 6 aspects of the job. The NASA-TLX method was developed by Sandra G. of the NASA-Ames Research Center and Lowell E. Staveland of San Jose State University in 1981 (S. Hart et al., 1999).

Number	Range of Value	Category of Workload
1	0% - 9%	Very Low
2	10% - 29%	Low
3	30% - 49%	Moderate
4	50% - 79%	High
5	80% - 100%	Very high

Figure 1. *Classification of workload value rating*

Work sampling

*Work sampling*is a technique for conducting a large number of observations on the performance activities of machines, processes or workers / operators (Sritomo Wignjosoebroto, 2003). Work measurement with the work sampling method can be classified as direct work measurement because the implementation of measurement activities must be carried out directly at the work place under study.

Fishbone Diagram

Fishbone diagram is often called Cause and Effect diagram is a diagram that resembles a fishbone that can show the cause and effect of a problem (John Bank, 1992). The fishbone diagram consists of 4M+E, man (human), method (method), machine (machine), material (production material), and environment (environment). These factors are useful for grouping the types of root causes into a category.

Adjustment Factor

The adjustment factor is to maintain and normalize the work shown by the operator. After the measurement takes place, if it is not normal to work, there is no seriousness shown by the operator (Sutalaksana, 2006). The adjustment factor in the measurement of working time is used to determine the normal time until the operator is in a certain process. If something unusual happens, the measurer needs to know and give a value according to the conditions that occur.

Research Methods

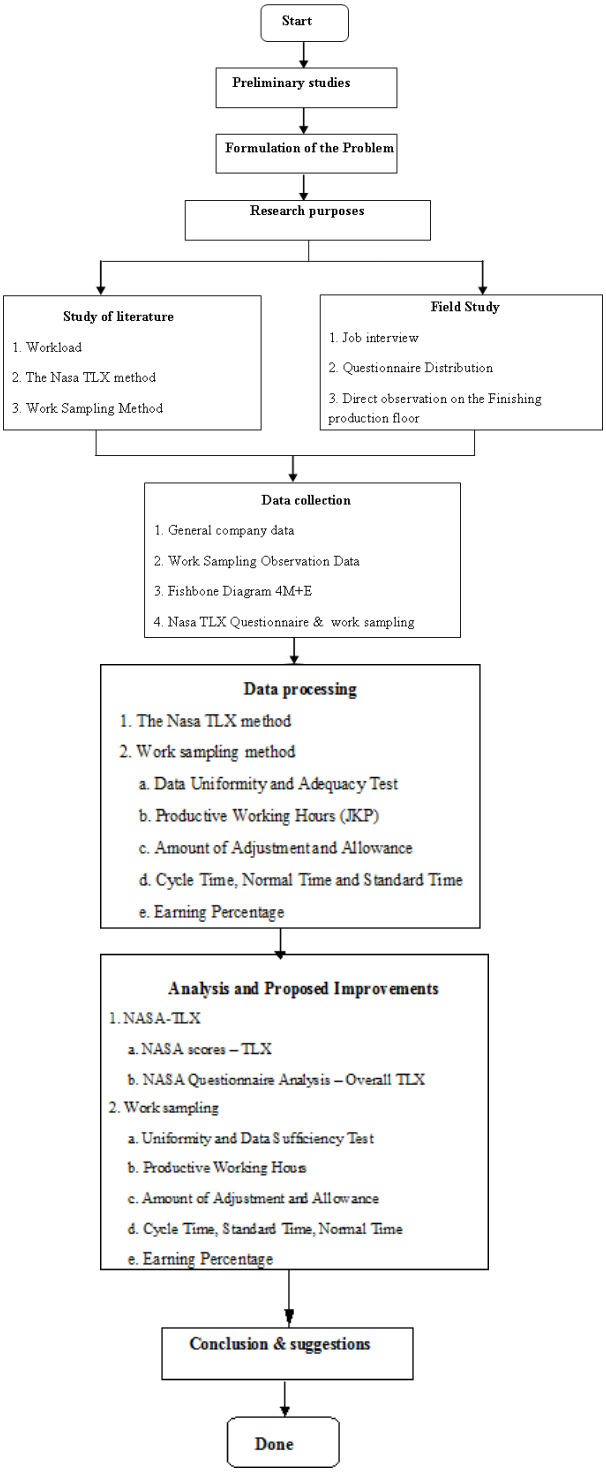


Figure 2. *Research flow chart*

Results and Discussion

NASA – TLX

After the workers fill out the weighting and rating questionnaires, the next step is to calculate the value of each indicator by multiplying the rating by the factor weight and calculating the Weight Workload (WWL).

Table 1. *Calculation of indicator values and WWL*

Work station	Name	Aspek	Bobot	Rating	Rating x Bobot	WWL
Finishing operator	Dede Nurholis	MD	3	100	300	1280
		PD	3	80	240	
		TD	3	90	270	
		OP	2	90	180	
		EF	1	80	80	
		ER	3	70	210	
Finishing operator	Nurman	MD	2	70	140	960
		PD	4	50	200	
		TD	1	60	60	
		OP	1	80	80	
		EF	2	90	180	
		ER	5	60	300	
Finishing operator	Rahma Purnomo	MD	1	90	90	1070
		PD	3	80	240	
		TD	3	80	240	
		OP	2	70	140	
		EF	3	50	150	
		ER	3	70	210	
Finishing operator	Ryan Dwi S	MD	2	70	140	1050
		PD	5	50	250	
		TD	1	80	80	
		OP	3	90	270	
		EF	1	70	70	
		ER	3	80	240	
Finishing operator	Andri Andrianto	MD	2	60	120	1010
		PD	3	70	210	
		TD	4	60	240	
		OP	2	80	160	
		EF	2	70	140	
		ER	2	70	140	

Workload

The mental workload is calculated based on the results of distributing questionnaires that have been filled out by the respondents through 2 stages, namely the scale-matching stage and the scoring stage. Indicators on the questionnaire include Mental Demand, Physical Demand,*Temporal Demands, Effort, Own Performance* and Frustration. It can be seen in the graph below that there is 1 finishing operator, namely Dede Nurholis, which is included in the category of very high mental workload with a score of 85. Meanwhile, there are 4 operators included in the category of high mental workload, namely Nurman with a score of 64, Rahma Purnomo with a score of 71, Dwi Rian S with a score of 70 and Andri Andrianto with a score of 67. Of the 5 finishing operators who have the highest mental workload fatigue, Dede Nurholis.

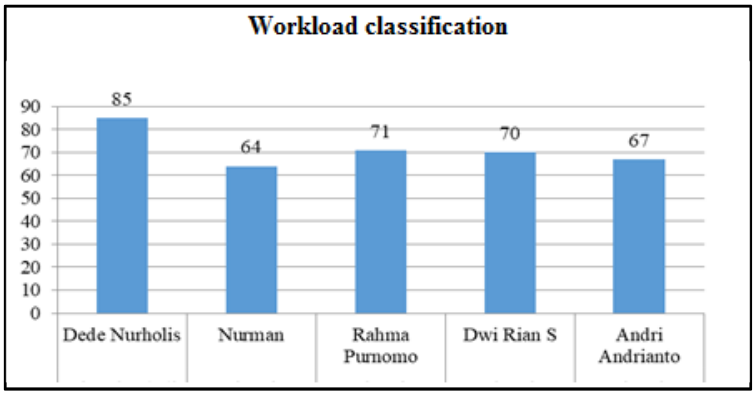
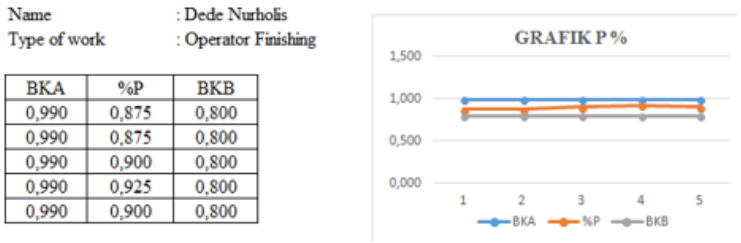


Figure 3. *Graph of mental workload classification*

Uniformity Test and Data Sufficiency Test

The data uniformity test was carried out to determine whether the data obtained were uniform or not. The data is said to be uniform if it does not exceed the upper control limit (BKA) and lower control limit (BKB). In this study, 95%

confidence level and 5% accuracy level were used.



Name Operator	*Work Station*	*N'*	*N*	*Description*
Dede Nurholis	*Operator Finishing*	180.27	200	*enough data*
Nurman	*Operator Finishing*	151.97	200	*enough data*
Rahma Purnomo	*Operator Finishing*	161.30	200	*enough data*
Ryan Dwi S	*Operator Finishing*	170.73	200	*enough data*
Andri Andrianto	*Operator Finishing*	170.73	200	*enough data*

Figure 4. *Uniformity test and operator data sufficiency test*

From the measurement results of the data adequacy test in chapter 4 the data of 5 operators is declared sufficient because N' < N. Where N is 200 which is obtained from the observation time data of 5 working days. Because the data is sufficien, it is not necessary to add data. The calculation data is continued to the next stage.

Determination of Productive Working Hours (JKP)

Table 2. *Determination of productive working hours (JKP)*

Name Operator	*Work Station*	*Productive Working Hours (JKP)*	*Description*
Dede Nurholis	*Operator Finishing*	142	*Hours/Month*
Nurman	*Operator Finishing*	146	*Hours/Month*
Rahma Purnomo	*Operator Finishing*	145	*Hours/Month*
Dwi Rian S	*Operator Finishing*	144	*Hours/Month*
Andri Andrianto	*Operator Finishing*	144	*Hours/Month*

Based on the calculation results, it was found that the highest productive working hours were Nurman with 146 hours/month, followed by Rahma Purnomo with 145 hours/month, and Dwi Rian S, Andri Andrianto with 144 hours/month. The results of these calculations can be caused by the heavy workload of operators who are rarely found unemployed when observing for 5 working days.

Determination of the Amount of Adjustments and Allowances

Table 3. *Operator adjustments and allowances*

No	Work Element	P	All
1	Take the Production order form in admin	1.1	0.28
2	Cleaning the work station desk	1.08	0.28
3	Take cutting pliers	1.05	0.19
4	Cutting the remaining supporting rods	1.06	0.20
5	Filing the remaining cuttings with a small rattan split file	1.07	0.28
6	Weigh the jewelry before sanding	1.13	0.29
7	Smooth the surface of the jewelry with sandpaper	1.06	0.28
8	Weighing jewelry after sanding	1.05	0.19
9	QC Checking Process on jewelry	1.04	0.19
10	Give From order QC to admin	1.05	0.19
11	Operate the soldering machine	1.05	0.19
12	Warming up the jewelry to be soldered	1.05	0.19
13	Take a stenlis container and alum water	1.05	0.19
14	Do the soldering process on jewelry	1.05	0.19
15	Inserting satong iron rod jewelry	1.05	0.19
16	Weighing jewelry after soldering	1.05	0.19

The adjustment used in this study is objective. Objective Method, there are two factors that must be considered for this method, namely the speed and difficulty of the work. These two factors are considered together to get normal time. Speed of work is speed in doing work in the usual sense. If the operator works normally, then p1=1. The speed is too high p1>1 and the speed is too slow p1.

Comparison of Finishing Operator Productivity Distribution

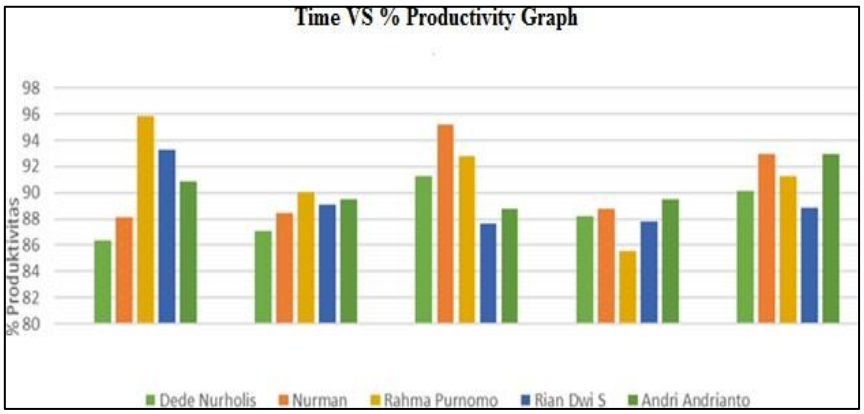


Figure 3. *Comparison graph of finishing operator productivity distribution*

In the graph above, it can be seen the difference in productivity between 5 operators during 5 days of observation. Where the highest graph occurs in operator Rahma Purnomo with an average value of 95%, then followed by Rian Dwi S with an average value of 93%, Nurman and Andri Andrianto have the same average value with a value of 92%.

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Fishbone Diagram

Fishbone diagram is used to determine the factors that affect the workload experienced by finishing operators. The following will explain the causal relationship of the workload using a fishbone diagram. *Man* become the main factor in the fishbone diagram, due to the high level of fatigue due to work demands causing the operator to not be able to fully concentrate on doing his job, the high level of fatigue resulting from poor time management by the operator, causing operator work performance that is not optimal. *Method* being the second factor in the fishbone diagram, SOPs that are not fully implemented as a whole can result in some work not being carried out properly so that production results are not optimal. Work that is not optimal will certainly require re-examination which causes additional working hours. The method aspect also refers to the workload that must be completed quickly due to requests from consumers. *Material* third factor in fishbone diagram which discusses the limitations of machine tools repair. Limited tools like workers have to give more effort because some work must be done manually. Work that is done manually and coupled with the number of orders or requests from consumers will certainly be burdensome or put a burden on workers. *Machine* is the fourth factor in the fishbone diagram which refers to the use of machine overhead. This can make the worker's time longer because workers are required to repair the system of the machine used and if it causes damage to the machine, the quality of the product will also be affected. The mismatch of product expectations with work related to product quality is due to the machine used by workers. *Environment* be the last factor in the causal analysis using a fishbone diagram. In the Environment aspect, it discusses the state of the work environment that is too noisy and the state of the room is messy. The work environment must of course always be considered in order to provide comfort to workers when carrying out activities. A noisy and dirty environment will cause an uncomfortable feeling when the operator is working. Decreased concentration will certainly result in lowering the performance of workers.

Conclusion

1. In the NASA-TLX method, it is known that there is 1 finishing operator, namely dede nurholis which is included in the category of very high mental workload with a score of 85 due to poor time management as seen from the number of non-productive work carried out so that the daily targets given by the company are not achieved. While there are 4 operators included in the category of high mental workload, namely Nurman with a scoreof 64, Rahma Purnomo with a score of 71, Dwi Rian S with a score of 70 and Andri Andrianto with a score of 67.
2. Fatigue is one of the causes of decreased productivity in employees. Based on the 4M+E analysis on the fishbone diagram, the man factor is the main problem causing the workload because the operator feels symptoms of excessive fatigue causing feelings of sluggishness, sleepiness, dizziness, lack of accuracy, lack of concentration, slow response and loss of enthusiasm for work with this fatigue. a decrease in employee productivity that affects the finishing process. In this process there is a decrease in gram weight before and after finishing. Based on the finishing productivity data, there are 5 operators who have a total value of gold gram losses exceeding the provisions given by the company.

3. There are 3 (three) factors that cause mental workload, namely lack of training and understanding of work for operators, poor time management and an inadequate work environment. The most dominant thing felt by finishing operators on the production floor is the demands of work from a human point of view. Because the work demands given by the company are evenly distributed between new employees and old employees. For the old employees, it is suggested to use headphones so as not to disturb the concentration of the new employees. Furthermore, the proposed improvements that can be made by PT. Abadi Korpora's passion is to design a product, which is a box that can be used in finishing work so that the gold flakes that are filed or sanded don't scatter on the table and can be collected for smelting so that there is a retrun which can reduce the loss of grams of gold. The following is a picture of the product proposal.

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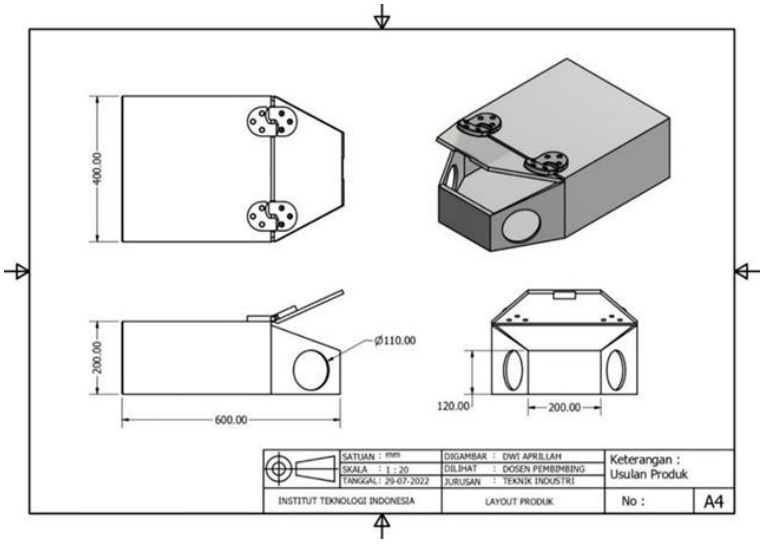

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