ISSN: 2581-1274

Analysis of Operators Physical and Mental Workload at Thresher Station at PT. Beurata Subur Persada (BSP) Nagan Raya

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ARTICLE INFO

Article history:
Accepted

Keywords:
%CVL
Physical Workload
Mental Workload
Operator

ABSTRACT

PT Beurata Subur Persada (BSP) is a company engaged in processing Fresh Fruit Bunches (FFB) into Crude Palm Oil (CPO) located in Nagan Raya District, Aceh Province. In carrying out the production process, the thresher station is one of the stations in the factory that functions as a machine that ejects fruit from the stage of the jongkos (palm stalk) by slamming the FFB into the thresher drum successively. However, based on initial observations, it is known that the BSP operator who controls the thresher machine also controls other machines, so this increases the physical and mental workload of the operators. The purpose of this study was to analyze the physical workload and mental workload of station operators using the %CVL method and the NASA-TLX method which are influenced by the subjectivity of the operators. The results of the study found that there were 2 operators who experienced rather high physical workloads, while the other 2 operators experienced moderate physical workloads. While measuring the mental workload it is known that all operators are in the moderate category.

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I. Introduction

Along with the development of the industrial era which is so complex, it requires every company to compete in order to be able to create optimal resources. Operators are a resource that has the mind, feelings, skills and knowledge to manage other resources [1]. Operators as human resources in an industrial world play a very important role in realizing the company's vision and goals, so it is very important for companies to continue to evaluate the capacity of operators according to their needs [2]. According to [1] the assignment of workloads to operators, every burden borne by operators must be balanced with the physical and mental capabilities received by operators, this is done to prevent fatigue and stress for operators. Therefore, every company that uses human resources needs to evaluate and measure the physical and mental workload of its operators.

Workload is any form of work that is assigned to someone to be completed [3]. According to [4] workload is assessed based on physical aspects and mental aspects. Physical workload, namely work that uses the physicality of a human being in the form of energy and muscles, while mental workload is workload by using the energy of the mind or psychology to complete its responsibilities. It can be said that if an operator's physical and mental workload is in good condition and balanced, it is certain that productivity in the company will increase.

PT Beurata Subur Persada (BSP) is a company engaged in processing Fresh Fruit Bunches (FFB) into Crude Palm Oil (CPO) located in Nagan Raya District, Aceh Province. In carrying out the production process, the thresher station is one of the stations in the factory that functions as a machine that separates the fruit from the palm stalk through the stages of slamming the FFB into the thresher drum in succession [5]. PT BSP currently has 5 units of thresher machines which are controlled by 4 people every day. However, based on initial observations, it is known that the BSP

operator who controls the thresher machine also controls other machines, so this increases the physical and mental workload of the operators. Therefore, it is necessary to measure the physical and mental workload of the operator concerned.

In previous research by [6] with the aim of measuring the workload of boiler operators through a physiological approach at PT BSP. The results obtained show that all operators are categorized as having a moderate workload and through the %CVL percentage the recovery pulse category is declared abnormal so that the company is required to make repairs as soon as possible. In addition, research by [7] which aims to measure the physical workload on Boiler operators at PT Socfindo using %CVL shows that there are 3 operators who have a low physical load category so they do not need repairs and 2 operators who experience high workloads so repairs are needed as soon as possible

Based on the problem phenomena and previous research above, the authors aim to analyze the physical and mental workload of Thresher Station operators at PT Beurata Subur Persada (BSP). In measuring the operator's physical workload, the authors use the %CVL method by calculating the operator's pulse, while measuring the mental workload is carried out using the National Aeronautics and Space Administration Task Load Index (NASA-TLX) method which is based on the subjectivity of the operators. The results of this study are expected to be able to provide an overview for the company to make improvements in the future, especially at the Thresher station.

II. Method

This research is a type of quantitative research by measuring or observing the physical workload and mental work of operators on thresher machines. Time and place of research conducted during September to December 2022 at PT BSP. The method for collecting research data was carried out using two methods, namely the measurement of %CVL to measure physical workload by calculating the work rate (DNK), resting work rate (DNI) and maximum heart rate for the operator. While the NASA-TLX method is used to measure the mental workload which is determined through the subjectivity of the operators . The following are the stages of the %CVL and NASA-TLX methods.

A. The %CVL method

The percentage of CVL (% CVL) is a calculation to determine the classification of workload based on the increase in working heart rate compared to the maximum heart rate. According to [7] indirect calculations can use a stopwatch with the 10 beats method. The measurement of the working pulse is done once an hour because the measurement of the pulse when workers do their work in one day tends to go up and down (depending on the activity being carried out). The steps for measuring physical workload with CVL percentages are as follows:

a) Measure the operator's pulse

The initial stage of measuring the physical workload begins with measuring the work pulse (DNK) during the production process which starts from 08.00-17.00. DNK measurement activities are carried out for 2 working days at the following times.

- First DNK measurement at 08.30 WIB
- Second DNK measurement at 09.30 WIB
- Third DNK measurement at 10.00 WIB

b) In the next stage, measurement of the resting pulse rate (DNI) is carried out when the operator begins to rest, namely at 12.00-13.00 WIB.
c) Then the next step is to determine the maximum pulse rate (DNK Max) through the following equation.
   Max DNK = 220 (Male) – Age
d) Then the next step is to calculate the working pulse (NK) through the equation:
   Work pulse = DNK – DNI
e) Then calculate %CVL with the following formula.
   % CVL = ((DNK-DNI))/(Max DN-DNI)
f) The last step, the output of the %CVL calculation is then compared with the predefined categories as shown in the following table:

Table 1. Category %CVL

1	<30%	No fatigue occurs
2	30% - <60%	Diperlukan perbaikan
3	60% - <80%	Kerja dalam waktu singkat
4	80% - <100%	Diperlukan tindakan segera
5	>100%	Tidak diperbolehkan beraktivitas

B. NASA-TLX method

NASA-TLX is a measurement technique used to analyze a person's mental workload in carrying out his activities [8]. According to [9] NASA-TLX is measured through 6 factors on workers namely, physical needs (KF), mental needs (KM), time requirements (KW), effort (U), performance (P) and level of frustration (TF). Based on these factors, the steps in measuring NASA-TLX are as follows.

a) Weighting

In this step, operators are asked to choose the most dominant factor in the occurrence of mental workload in their work activities. Then, each factor is weighted to determine which factor has the highest or lowest load.

b) Giving Ratings

The rating given is subjective depending on the mental load felt by the respondent in accordance with the workload felt, in this section a scale of 0-100.

c) Product Value Calculation

After the respondents gave weights and ratings, then the value of the product was calculated.

Product = weight x rating

d) Calculation of Weighted Workload (WWL) values

The next step is to calculate the WWL value by adding up the product values of the six workload indicators.

WWL = ∑ Product

e) WWL average value calculation

Next, the average WWL value is calculated in order to determine the average workload category

WWL = WWL/15

f) Interpretation of mental workload assessment

The mental workload assessment categories based on the NASA-TLX analysis are as follows.

Table 2. Categories of Mental Workload

No	Value Interval WWL	Category
1	0-9	Low
2	10-29	Moderate
3	30-49	Slightly tall
4	50-79	High
5	80-100	Very High

III. Results and Discussion

A. Measurement of Physical Workload

In measuring the physical workload, the authors measured DNK and DNK to 4 operators at the theresher station for 2 working days. The measurement of working pulse was carried out at 08.00 WIB on the first day and 09.00 on the second day, while the DNI was measured after the operators had worked, namely at 12.30 WIB. The following is the result of the DNK and DNI measurement data compilation for each operator.

Table 3. Data Summary of DNI and DNK Operators

Name Operators	Age	Working Days	DNI (second)	DNLK (second)		
				1	2	3
Operator 1	24	Hari 1	10,20	6,70	6,50	5,12
		Hari 2	12,12	6,48	5,98	5,01
Operator 2	25	Hari 1	7,23	6,45	6,03	5,20
		Hari 2	7,61	6,79	6,09	5,04
Operator 3	28	Hari 1	7,34	6,80	6,21	5,78
		Hari 2	7,61	6,83	6,12	5,56
Operator 4	34	Hari 1	11,10	6,20	5,78	5,01
		Hari 2	11,40	6,50	5,90	5,20

Source: Research Data Collection 2023

Based on the data above, the calculation is then carried out using the DNK and DNI using the 10 beats method and then averaged to obtain the following results.

Table 4. Average DNI and DNK Operators

Name Operators	Age	DNI Average	DNK Average
Operator 1	24	101,955825	54,16
Operator 2	25	102,307565	80,92
Operator 3	28	97,0767492	80,29
Operator 4	34	104,954687	53,34

Source: Research Data Collection 2023

The results of obtaining the average DNI and DNK operators through using the 10 beats method. Then the calculation of %CVL for each operator can be presented in the following table.

Table 5. Calculation of %CVL

Name Operators	Age	DNI Average	DNK Average	DN MAKS	NK	%CVL	
						Percentage	Category
Operator 1	24	54,16	101,96	196	47,79	34%	Slightly tall
Operator 2	25	80,92	102,31	195	21,39	19%	Moderate
Operator 3	28	80,29	97,08	192	16,78	15%	Moderate
Operator 4	34	53,34	104,95	186	51,61	39%	Slightly tall

Source: Research Data Collection 2023

Based on the %CVL calculation above, it can be seen that there are 2 operators who experience a rather high physical workload, while the rest experience a moderate workload. This represents that some operators experience heavy work, while some do not. Therefore, companies need to identify energy consumption for operators to reduce physical workload.

B. Measurement of Mental Workload

Measurement of mental workload was carried out using the NASA-TLX method for 4 operators working at the theresher station. The NASA-TLX measurement is measured through 6 factors for workers namely, physical needs (KF), mental needs (KM), time requirements (KW), effort (U), performance (P) and level of frustration (TF). Then the following is a step for measuring the value of NASA-TLX for operators starting from the weighting of each factor. Weighting is done by distributing questionnaires to operators on mental workload factors by giving a value of 1-5. The following is a recapitulation of operator weighting results.

Table 6. NASA-TLX Factor Weighting

Name Operators	Indicator						Total
	KF	KM	KW	U	P	TF	
Operator 1	2	3	1	2	1	1	10
Operator 2	2	1	3	1	2	1	10
Operator 3	2	1	2	2	2	2	11
Operator 4	1	2	2	1	1	2	9

Source: Research Data Collection 2023

Based on the weighting results above, it is known that the highest total weight value is obtained from operator 3, namely 11, and conversely, the lowest total weight value is achieved by operator 4, namely 9, while operators 1 and 2 have the same weight, namely 10.

After weighting, measurement is then carried out through the rating of each operator on the physical workload factors. In determining the rating, the author uses a scale of 1-100 to submit a rating questionnaire by the theresher operator. Thus, the recapitulation of the NASA-TLX rating for each operator is presented as follows.

Table 7. Rating on NASA-TLX Factors

Name Operators	Indicator						Total
	KF	KM	KW	U	P	TF	
Operator 1	40	40	30	50	20	30	210
Operator 2	30	30	40	40	30	50	220
Operator 3	20	20	20	30	40	20	150
Operator 4	30	50	30	30	40	40	220

Source: Research Data Collection 2023

From the table above, it can be seen that the highest total rating given to operators 2 and 4 is worth 220, while the lowest is given by operator 3 which is worth 150 and operator 1 gives a rating worth 210.

Based on the results of determining weights and ratings on mental workload factors for theresher operators, the authors then calculate Weighted Workload (WWL) in order to be able to analyze the mental workload faced by operators based on the categories obtained. Following are the results of WWL calculations presented in the following table.

Table 8. WWL Calculation

Name Operators	Indicator						Total	Value WWL	Category
	KF	KM	KW	U	P	TF			
Operator 1	80	120	30	100	20	30	380	25,33	Moderate
Operator 2	60	30	120	40	60	50	360	24,00	Moderate
Operator 3	40	20	40	60	80	40	280	18,67	Moderate
Operator 4	30	100	60	30	40	80	340	22,67	Moderate

Source: Research Data Collection 2023

Based on WWL calculations for each operator, it is known that all operators are in the moderate category. This means that all operators do not experience a heavy mental burden, however, the company must continue to review and evaluate the mental workload of the operators, both to provide motivation and direction in order to achieve productivity at work.

IV. Conclusion

Based on data processing, it is known that there are 2 operators who experience a rather high physical workload, while the rest experience a moderate workload. This represents that some operators experience heavy work while some operators do not. Therefore, companies need to identify energy consumption for operators to reduce physical workload. While measuring the mental workload it is known that all operators are in the moderate category and do not experience a sufficiently heavy mental load, but the company still has to continue to review and evaluate the mental workload of the operators both to provide motivation and direction in order to achieve productivity at work.

REFERENCES

[1] A. Maretno and Haryono, "Analisa Beban Kerja Fisik dan Mental dengan Menggunakan Work Sampling dan NASA-TLX Untuk Menentukan Jumlah Operator Analysis Physical and Mental Workload Uses Work Sampling and NASA-TLX To Decide Operator Number," *Din. Rekayasa*, vol. 11, no. 2, pp. 54–62, 2015.

[2] N. Nurhayani, "Pengukuran Beban Kerja Pada SDM Operator Produksi Dengan Metode Cardiovascular Load (Cvl) Dan NASA-TLX," *Media Nusant.*, vol. XVIII, no. Cvl, pp. 29–36, 2022.

[3] F. Setyaning Handika, E. Indah Yuslistyari, and ruf Hidayatullah, "Analisis Beban Kerja Fisik Dan Mental Operator Produksi Di Pd. Mitra Sari," *J. InTent*, vol. 3, no. 2, pp. 82–89, 2020.

[4] R. A. M. Puteri and Z. N. K. Sukarna, "ANALISIS BEBAN KERJA DENGAN MENGGUNAKAN METODE CVL DAN NASA-TLX DI PT. ABC," *Spektrum Ind.*, vol. 15, no. 2, pp. 211–222, 2017.

[5] S. Heriyanti and T. M. A. Pandria, "Analisis Perawatan Mesin Sterilizer Menggunakan Metode Overall Equipment Effectiveness Di PT Surya Panen Subur II," vol. 19, no. 2, pp. 289–294, 2022.

[6] Y. Hidjrawan, "Pengukuran Beban Kerja Operator Boiler Berdasarkan Denyut Nadi," vol. 8, no. 1, pp. 106–110, 2022.

[7] J. Samosir and S. Sofiyanurriyanti, "Analisis Beban Kerja Operator pada Stasiun Boiler Menggunakan Cardiovascular Load (CVL) (Studi Kasus: PT. Socfindo Indonesia Perkebunan Seunagan)," *J. Optim.*, vol. 8, no. 1, p. 119, 2022, doi: 10.35308/jopt.v8i1.4680.

[8] V. M. Afma, "Analisa Beban Kerja Operator Inspeksi Dengan Metode NASA-TLX (Task Load Index) Di PT. XYZ," *Profisiensi*, vol. 4, no. 2, pp. 118–122, 2016.

[9] A. Hakiim, W. Suhendar, and D. Agustina Sari, "Analisis Beban Kerja Fisik Dan Mental Menggunakan Cvl Dan Nasa-Tlx Pada Divisi Produksi Pt X," *Barometer*, vol. 3, no. 2, pp. 142–146, 2018, doi: 10.35261/barometer.v3i2.1396.