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Mental Load Analysis Using NASA-TLX on Production Operators at PT. Cemindo Gemilang North Sumatra

Reakha Zulvia, Andre Josua Sitompul
Universitas Medan Area, Indonesia
Email: reakhazulvia@gmail.com, andrejosua1997@gmail.com
Correspondence: reakhazulvia@gmail.com

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ABSTRACT
Workload is a job demand that arises from receiving orders or requests, which directly impacts an individual's performance. Mental workload can be influenced by various factors, such as overtime, poor social relations between departments, and environmental conditions like low temperatures. This study aims to determine both the minimum and maximum mental workload and identify the contributing factors using the NASA Task Load Index (NASA TLX) and Cardiovascular Load (CVL) method. The research focuses on measuring the subjective mental workload of employees, particularly in a production environment. Using the NASA TLX method, six indicators—mental demand, physical demand, temporal demand, performance, effort, and frustration—were assessed and scored. Additionally, the CVL method was employed to measure cardiovascular load as an objective measure of mental workload. The findings suggest that certain factors, including extended working hours, interdepartmental communication issues, and environmental conditions, significantly contribute to high mental workload. This study provides insight into the key factors influencing mental workload, offering valuable recommendations for reducing workload-related stress in the workplace and enhancing employee well-being. Future research could expand on these findings by exploring specific interventions to address identified causes.

Introduction

Workload is an essential aspect that every company must consider, as it significantly affects employee productivity and overall work performance. The definition of workload varies among experts, often differing in the boundaries and types of work it encompasses. Generally, workload can be understood as the difference between the worker's capacity or ability and the demands placed upon them by their job (Adriansyah et al., 2023; Anggraini & Irsan Pratama, 2022; Azwar, 2020; Permata Sari, 2018; Prasetya & Gisela, 2021). This imbalance between demand and capability is a key factor in determining how workloads are experienced and managed by employees. In the context of workplace productivity, workload includes both physical and mental

demands that employees are expected to meet (Annisa & Darajatun, 2022; Mahfira & Andres, 2018; Pradhana & Suliantoro, 2019; Prastika et al., 2020; Putri & Handayani, 2019).

Mental workload, in particular, has gained significant attention in recent years, especially in industries where the demands are high, and the consequences of employee stress are far-reaching. When employees face a workload that exceeds their physical or mental capabilities, it can result in negative health outcomes, such as stress, burnout, or other work-related disorders. The impact of mental workload is often compounded by environmental factors such as long working hours, poor social relations with colleagues, or challenging physical conditions like extreme temperatures (Amanda Putri et al., 2018; Junialdo, 2023; Masniar et al., 2022; Muh Anhar et al., 2022; Surya et al., 2018).

The mental workload is crucial in determining the level of employee engagement, job satisfaction, and the overall well-being of individuals in the workplace. Understanding the causes and effects of mental workload allows organizations to improve both their work environment and work processes. This is particularly relevant for organizations looking to optimize employee performance while minimizing the risk of negative health outcomes associated with excessive workload.

Furthermore, in the workplace, workload isn't merely the physical burden of completing tasks, but also the mental and cognitive strain that arises from juggling multiple responsibilities. With advancements in technology and a global shift toward more digitally integrated work environments, the demands on mental workload have only intensified. As a result, accurately measuring and understanding mental workload using reliable tools, such as the NASA TLX method, has become essential in modern work environments.

One relevant study by Tantrinesia et al. (2023) examined the relationship between workload and employee performance but primarily focused on physical workload and the direct correlation to productivity. However, this study did not address the impact of mental workload, which is a significant contributor to overall employee well-being and performance. The current study addresses this gap by using both subjective and objective measurements, such as the NASA TLX and CVL methods, to analyze mental workload and its effects on employees' productivity and health. This dual approach offers a more comprehensive view of the workload impact, both from a mental and physical perspective.

Another study by Wati et al. (2019) investigated mental workload in a manufacturing environment but primarily focused on physical aspects, such as working hours and ergonomics. Although it acknowledged the presence of mental workload, it did not delve deeply into the emotional or cognitive aspects that contribute to the strain. This research fills the gap by offering a more thorough analysis of mental workload, incorporating emotional and cognitive stressors, and how they affect performance and health in both manufacturing and office environments.

The objective of this research is to analyze the causes and effects of mental workload using both the NASA TLX method and CVL method, focusing on how these factors affect employee performance and well-being. By identifying the key stressors and factors contributing to mental workload, the study aims to provide insights into how businesses can manage and alleviate mental strain among employees. The findings of this research can guide companies in creating a more balanced work environment that reduces stress and enhances productivity, ultimately leading to better employee health and organizational performance. Furthermore, the study's results could help in developing policies aimed at preventing overburdening employees, fostering a healthier and more sustainable work culture.

Materials and Methods

Initial This study was conducted to measure physical workload and mental workload subjectively using an oximeter measuring device and providing a NASA-TLX questionnaire. This research was conducted at 11.00 - 13.00 WIB. It is intended that this research has subjective value by workers to get the value of the mental workload which can then be used as material for analysis and proposal by researchers. The object of this research is the mental load of a worker calculated through the NASA-TLX method.

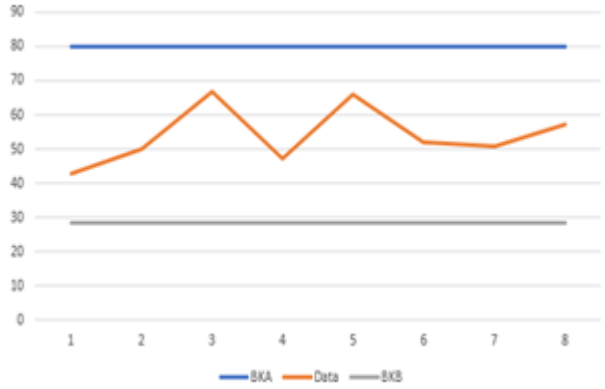

Figure 1. Data Uniformity Graph

Table 1. Workload Assessment

Category	Average
Low	0 - 9
Keep	10 - 29
Quite High	30 - 49
Tall	50 - 79
Very High	80 - 100

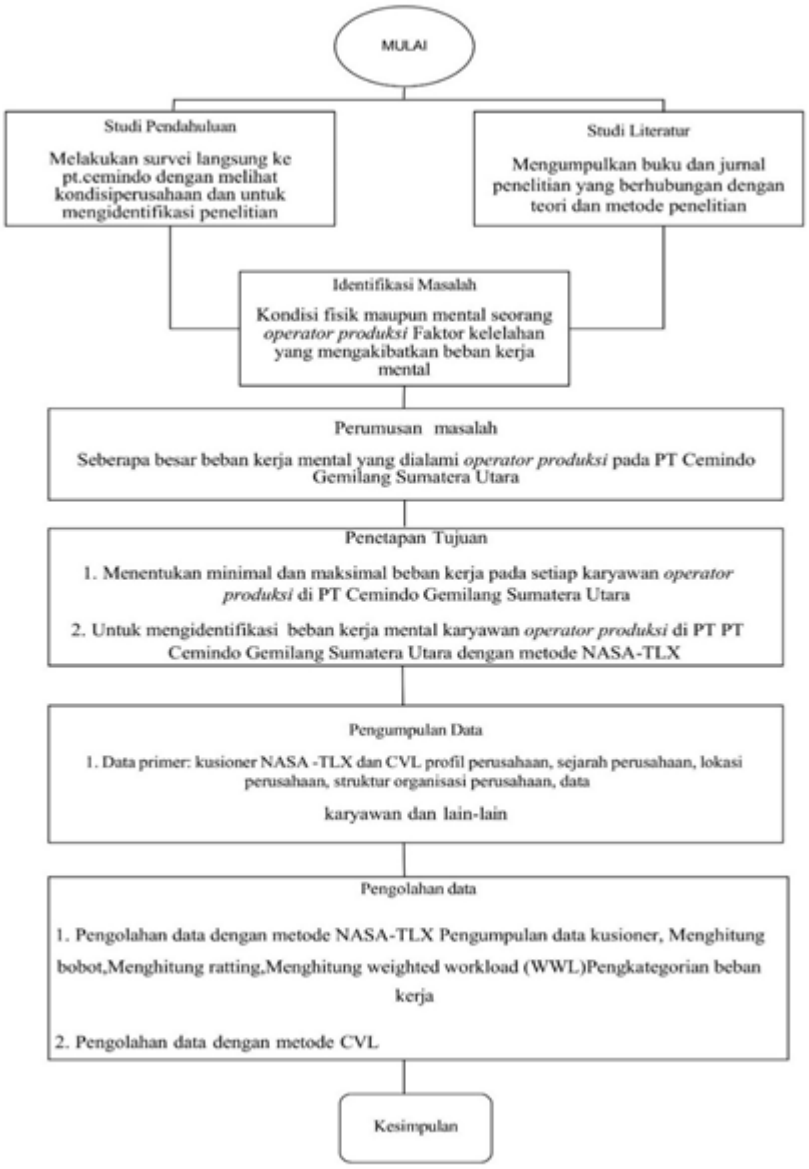

Figure 2. Research Flowchart

Results and Discussions

Data was obtained from filling out questionnaires that were distributed to workers with the same job. To test the adequacy of the data, the uniformity and sufficiency of data tests were conducted as follows.

Uniformity Test

$$x = \frac{\sum x_i}{n} = \frac{42.66+50+...+57.33}{8} = \frac{432,67}{8} = 54.08 \quad (2)$$

$$\sigma = \sqrt{\frac{\sum(x_i-\bar{x})^2}{n-1}} = \sqrt{\frac{(42.66-54.08)^2+(50-54.08)^2+...+(57.33-54.08)^2}{8-1}} = \sqrt{\frac{519.5}{7}} = 8.61 \quad (3)$$

$$BKA = \bar{x} + 3\sigma = 54.08 + 3(8.61) = 79.91 \quad (4)$$

$$BKB = \bar{x} - 3\sigma = 54.08 - 3(8.61) = 28.25 \quad (5)$$

Based on the above equation, it was found that the limit value obtained was BKA of 79.91 and BKB of 28.25 while the NASA-TLX score obtained was the highest of 66.66 and the lowest was 42.66.Thus the NASA-TLX score obtained was not outside the limit and can be said to be uniform. So that the data can be carried out to the next stage, namely the sufficiency of data.

Data Sufficiency Test

The calculation of the data sufficiency test with a confidence level of 90% (k = 1.65) and a degree of accuracy of 10% (s = 0) N' = 6,004 and N = 8, so that the value of N' < N, so that it can be said that the data is sufficient to be used as research material with a level of confidence of 90% and an accuracy level of 10%. This indicates that at least 90 out of 100 average values of the data have deviations of less than 10%.

Table 2 .Weighting Results

No	Age	KM	KF	KW	PF	YOU	TF	
1	M Ali Typhoon	43	4	2	3	1	3	2
2	Rehan Andari	28	4	2	3	2	2	2
3	Ajib Sirait	33	3	1	4	2	3	1
4	M Iqbal	26	4	2	3	1	3	2
5	Rusdi Sinaga	39	2	2	4	3	2	1
6	Esra News	27	3	2	4	2	2	2
7	Akbar Alfiandi	26	4	2	2	3	3	1
8	Imran Rizki	34	3	2	4	2	1	3
9	Putra Sianturi	35	2	3	4	2	2	2
10	Princess Yani	27	4	2	4	3	1	1
11	Yazid Lubis	30	4	3	2	3	1	1
12	Hermanto Pasaribu	40	2	3	4	2	2	1
13	Dhedek Ihsan	37	3	4	1	2	3	2
14	Faisal Musri	32	3	4	2	2	2	2

15	Ridho Hafis	41	4	3	2	2	3	1
16	Fandi Ahmad	36	2	4	3	3	2	1

Source: processed data

Table 3 Advanced Weighting Recapitulation Data

No	Name	Age	KM	KF	KW	PF	YOU	TF
17	Herman Maulana	28	3	3	3	1	3	2
18	Fauzan Harahap	33	4	3	3	2	1	1
19	Andika Pratama	40	3	4	2	3	2	1
20	Aldi Putrama	43	4	3	2	3	1	2
21	Revelation of Panjaitan	27	4	4	1	2	2	2
22	Daffa Anggara	25	3	4	2	3	2	1
23	Wahyu Siregar	31	4	3	2	2	2	1
24	Mhd Ryan Aulia	29	3	4	3	2	1	1

Source: processed data

The next step after weighting is to give a rating. This is done by subjectively asking workers about each NASA-TLX indicator. The rating results can be seen in Table 4

Table 4 Rating Results

No.	Name	Age	KM	KF	KW	PF	YOU	TF
1	M Ali Typhoon	43	60	70	50	80	40	50
2	Rehan Andari	28	60	50	40	50	40	50
3	Ajib Sirait	33	40	60	70	60	40	50
4	M Iqbal	26	50	60	40	60	60	60
5	Rusdi Sinaga	39	60	70	50	50	60	60
6	Esra News	27	50	60	50	70	60	40
7	Akbar Alfiandi	26	70	60	40	80	70	50
8	Imaran Rizki	34	50	50	70	50	60	60
9	Putra Sianturi	35	70	60	40	40	60	50
10	Princess Yani	27	50	70	60	50	40	50
11	Yazid Lubis	30	70	80	60	70	70	40
12	Hermanto Pasaribu	40	70	60	70	80	60	60
13	Dhedek Ihksan	37	40	50	40	60	50	50
14	Faisal Musri	32	70	60	70	60	70	60
15	Ridho Hafis	41	50	40	40	60	50	50
16	Fandi Ahmad	36	70	60	70	80	60	60
17	Herman Maulana	28	80	70	80	50	60	40
18	Fauzan Harahap	33	60	70	60	80	90	80
19	Andika Pratama	40	70	60	60	80	60	70
20	Aldi Putrama	43	80	50	70	60	80	80
21	Revelation of Panjaitan	27	60	70	80	70	70	70

22	Daffa Anggara	25	80	70	70	60	40	50
23	Wahyudi Siregar	31	60	50	70	60	80	60
24	Mhd Ryan Aulia	29	70	60	80	40	50	50

Source: processed data

Ratting Validity Test

This validity test is used to test the validity of the respondent's answer in the ratting section. The answer is said to be valid if r is greater than r table. Validity testing was carried out using the moment and spss 21 product correlation formula with a 95% confidence level.

Then to calculate the validity then use spss version 21. The data is said to be valid if r counts are greater than r tables. Because this questionnaire consists of 24 respondents, the R value of the table used in this study is 0.404 and the recapitulation of the results of the ratting validity test for each dimension of the workload is as follows:

Table 5 Rating Validity Test

Workload Dimensions	R Count	R Table	Information
KM (Mental Needs)	0.621	0.404	Valid
KF(Physical Needs)	0.421	0.404	Valid
KW (Time Requirement)	0.611	0.404	Valid
PF(Performan)	0.527	0.404	Valid
TU(Business Level)	0.712	0.404	Valid
TgF(Frustration Level)	0.611	0.404	Valid

Source: processed data

Conclusion

Based on the results of data processing and analysis carried out, the conclusions of the study were as follows: Based on the results of the calculation using the NASA TLX method, it was obtained that out of 24 employees who experienced a mental workload, there were as many as 6 workers who experienced a high mental workload, namely: Andika Pratama from the production operator of 61.33%. Hermanto Pasaribu from the production operator analysis was 63.33%, Faisal Musri was the production operator was 64.67%, Fandi Ahmad from the production operator was 71.33%, Daffa Anggara from the production operator was 68.66%, Wahyudi Siregar from the production operator was 61.33%. Based on the results of the calculation of physical workload using the percentage of CVL and the results of processing NASA TLX questionnaire data as many as 6 workers who experienced a fairly high mental workload and physical workload. Indicators that affect the 6 workers include the amount of work experienced by the worker, external factors of the body, and internal factors of the body by the workers themselves.

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