JURNAL ILMIAH TEKNIK INDUSTRI
ISSN: 1412-6869 (Print), ISSN: 2460-4038 (Online)
Journal homepage: http://journals.ums.ac.id/index.php/jiti/index
doi: 10.23917/jiti.v24i2.12495

Mental Workload Analysis of Liquid and Solid Division Employees at PT Sanbe Farma Using NASA-TLX

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Abstract. *This study aims to analyze the mental workload of employees in the Liquid and Solid Production Divisions at PT Sanbe Farma Unit I using the NASA-Task Load Index (NASA-TLX) method. High mental workload can affect performance, productivity, and work safety, particularly in production processes that are not yet fully integrated. The research involved 30 respondents (16 employees from the Liquid Division and 14 from the Solid Division) through questionnaires covering six mental workload indicators: mental demand, physical demand, temporal demand, own performance, effort, and frustration level. Data were analyzed through weighting, rating, product value calculation, and weighted workload (WWL) computation. The results showed that most employees experienced high to very high workload levels, with NASA-TLX scores ranging from 54.67 to 96.00. The highest average score was found in the own performance indicator, followed by mental demand and temporal demand. The main factors contributing to the high mental workload included tight production targets, manual recording processes, heavy physical tasks, and the lack of integrated systems between departments. Recommendations include increasing rest periods and improving work systems to reduce employees' mental workload.*

Keywords: *mental workload, NASA-TLX, pharmaceutical industry, ergonomic, workload measurement*

I. INTRODUCTION

Human resources (HR) refer to the abilities of a person or group of individuals to enhance business management to provide goods and services that satisfy the demands of the community. Since the HR component is a component of the work system, it receives a lot of attention. The HR category includes labor, employes, workers, or staff who work for a company. HR is one of the most important aspects of a company, along with capital, machinery, information, and other factors, so it must be well-managed to increase the effectiveness and efficiency of a company. Human resource issues significantly impact company performance development because human resources are a living variable with diverse characteristics and abilities, exerting a substantial influence on the success of the relevant work system in achieving its goals. (Sutalaksana et al., 1979).

Workload is the quantity of energy used by a human-performed work system on a spesific task. Thus, workload is primarily concerned with the human or individual doing a task under circumstances at a given moment. (Hancock & Meshkati, 1988). According to Henry R. Jex., (1988) mental workload is the difference between the workload demands of a task and a person's maximum mental capacity under motivated conditions. Employees' psychological aspects of their jobs can change at any time. Both internal and external factors might contribute to changes in psychological features. The tasks assigned, including their level of difficulty and job responsibilities; the infrastructure and facilities at work; the organization or company, including its working hours, shifts, rest periods, organizational structure, and pay; and the work environment are examples of external factors. Furthermore, the term "internal factors" refers to elements that are specific to the employee, such as age, gender, motivation, ambition, and health (Sasongko et al., 2017). Calculating a company's workload is particularly significant because mental workload is asymptomatic or doesn't exhibit any changes in personnel while they are working, but it can

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Submited: 18-08-2025 Revised: 18-11-2025
Accepted: 16-12-2025

Table 1. Mental Workload Indicators

No	Factor	Rating	Explain
1	*Mental demand* (MD)	Low, Very High	The mental activities and perceptions required (thinking, deciding, calculating, remembering, paying attention, searching). Whether it is easy or difficult to do, simple or complex, requires precision or not.
2	*Physical demand* (PD)	Low, Very High	Physical activities required (pushing, pulling, turning, controlling, operating). Whether the task is easy or difficult to perform, whether the movements required are fast or slow, and whether they are tiring or not.
3	*Temporal demand* (TD).	Low, Very High	The time pressure given to complete the task. Whether the work is done quickly or slowly.
4	*Own performance* (OP)	Low, Very High	How successfully an employee completes the tasks assigned by their supervisor. Whether the employee is satisfied with their performance while doing their job.
5	*Effort* (EF)	Low, Very High	How hard must workers work to achieve the desired level of performance during their working hours?
6	*Frustation* (FR)	Low, Very High	Levels of security, lack of enthusiasm, feelings of disturbance, and stress when compared to feelings of security and relaxation during work.

directly affect work output (Riza Fauzy et al., 2019).

Excessive work pressure brought on by deadlines or pressure from other sources makes employees think all the time, which in turn generates erratic emotions and, eventually, job stress (Fauzi, 2017). Therefore, in a company, operators must have the lowest possible mental workload to support the existing production process. A low mental workload will result in maximum production, as operators will feel safe, comfortable, and motivated in their operations, enabling them to perform and produce at their best. Based on previous research, studies related to mental workload have been widely conducted using the NASA Task Load Index (NASA-TLX) method, which is one of the methods for evaluating subjective workload. The NASA-TLX method measurement is divided into two stages: comparing each scale (Paired Comparison) and assigning values to the work (Event Scoring) (Pradhana et al., 2018). This method emerged from the need for subjective measurement, initially consisting of 9 factors: task difficulty, time pressure, type of activity, physical effort, mental effort, performance, frustration, stress, and fatigue. These factors were later simplified into 6 main factors: mental demand, physical demand, temporal demand, performance, frustration, and effort (Ishak et al., 2023). The explanation of the indicators can be seen in Table 1.

Previous research discussing the mental workload of workers using the NASA-TLX method was conducted by Kamari Ghanavati et al., (2019) which discusses the high mental workload scores of operators in industrial control rooms. This research shows that the higher the scores on the mental dimension and time demands, the lower an individual's work performance and readiness, which can increase safety and productivity risks. Next, the research by Fithri & Syahfikri, (2021) which examined the extent of mental workload among bakery employes, and the research by Dhiya & Rahmah, (2019) which examined the extent of mental workload among employes in the packaging division. As for research discussing the mental workload of military personnel, such as Ferianto et al., (2018) which discusses the indicators causing excessive mental workload in officers at the warship level and between departments with higher mental workloads, and research by (Riono et al., (2018) quantify the mental workload of Indonesian Navy personnel for each type of work during operations.

PT Sanbe Farma is a pharmaceutical company that develops formulations, produces, and sells safe and high-quality pharmaceutical products. The products produced include

Anesthetics, Antibiotics, Antihistamines, Infusions, Over-the-Counter Medications, and Veterinary Medicines. The Production Division is the most important division in producing the medications needed by consumers. There are three Production Divisions: Veterinary, Human Medicine, and Hormones. This human medicine production division is divided into Liquid and Solid Medicine Divisions based on the kind and consistency of the drug being made. Drugs in capsule and coated form are produced by the Solid Division, whereas syrup and dry syrup pharmaceuticals are produced by the Liquid Production Division.

Operators should ideally be able to do duties efficiently and without experiencing any major disruptions or mental strain. The more effectively and efficiently employees perform their jobs, the closer the organization will be to achieving its objectives. The situation is different, though, if employees are worn out by the heavy or challenging workload they are given (Widyastuti et al., 2023).

Consequently, operators will be more productive when they are not burdened with mental workload, which will allow them to generate outputs that meet time and quantity requirements. Based on interviews with operators in the Liquid and Solid Production Division, they reported that many production tasks, including recording the commodities produced, operating machinery, OEE, and what production is now underway, are still carried out manually and that the current system is still not integrated.

Based on the problems occurring at PT Sanbe Farma Unit I, a mental workload analysis was conducted to determine the level of mental workload experienced by workers at PT Sanbe Farma Unit I, specifically in the Liquid and Solid Production Divisions. The analysis was performed using the NASA-Task Load Index (NASA-TLX) method.

II. RESEARCH METHOD

This research focuses on the workforce working in the Liquid and Solid Division of PT Sanbe Farma Unit I. Additionally, data collection was carried out in two stages: primary and secondary data collection. Primary data collection was done by directly observing and observing the research object, while secondary data collection involved documents obtained from the company (internal data) and from literature studies (external data) such as company descriptions. Steps in measuring mental workload using the NASA-TLX method (Fathimahhayati, 2018):

1. Weighting. Weighting is obtained from calculations based on the assessments given by the workers. The questionnaire given to the workers required them to choose one of two paired indicators for each of the 15 pairs, based on the most influential indicator. Then the total tally for each indicator that is perceived to be more influential will be calculated. The number of tallies becomes the weight for each mental workload indicator.
2. Rating. The rating is given by workers thru a questionnaire provided. The rating given is subjective, depending on the mental workload perceived by the worker. The rating given by respondents is 0 for low values and 100 for high values. Meanwhile, to obtain the NASA-TLX mental workload score, the weights and ratings for each indicator are multiplied, then summed and divided by 15 (the number of paired comparisons).
3. Calculating Product Value. The product value is obtained by multiplying the rating by the factor weight for each indicator. This will result in 6 product values for the 6 indicators (MD, PD, TD, OP, FR, EF):

$$Product\ Value = Rating \times Weighting\ Factor \quad \ldots (1)$$

4. Calculating Weighted Workload (WWL). The product values obtained will be summed up to produce the WWL.

$$WWL = \sum Value\ Product \quad \ldots (2)$$

5. Calculating Average WWL The average WWL is obtained by dividing the WWL by the number of pairwise comparisons, which is 15.

$$Score\ NASA - TLX = \frac{WWL}{15} \quad \ldots (3)$$

6. Score Interpretation. Based on the explanation by Hart & Staveland, (1988) in the NASA-TLX theory, the workload scores obtained are divided into 5 categories:
   a. 0 – 9: Low workload
   b. 10 – 29: Moderate workload
   c. 30 – 49: Moderate to high workload
   d. 50 – 79: High workload
   e. 80 – 100: Very high workload

III. RESULT AND DISCUSSION

Research Data

This research was conducted by distributing questionnaires for 16 workers in the Liquid Production Division and 14 workers in the Solid Production Division, resulting in a total of 30 respondents.

1. Indicator Weighting with NASA-TLX. The indicator weighting data for NASA-TLX was obtained from questionnaires completed by the workers. Next, the questionnaires were tallied to count the number of times each indicator was perceived as the most influential. This tally count then becomes the weight for each mental workload indicator. The results of the questionnaire were summarized in a tally questionnaire which can be seen in Table 2.

Table 2. Weighting Results with NASA-TLX

Operator	Indicator						Total
	MD	PD	TD	OP	EF	FR	
1	4	0	2	3	2	4	15
2	3	0	2	3	2	5	15
3	3	0	2	3	2	5	15
4	3	0	2	3	2	5	15
5	0	2	2	2	4	5	15
6	2	5	3	1	2	2	15
7	5	0	3	2	2	3	15
8	4	0	2	3	3	3	15
9	4	0	2	3	2	4	15
10	1	3	2	2	2	5	15
11	1	3	2	2	2	5	15
12	1	5	3	2	2	2	15
13	5	1	3	4	2	0	15
14	2	4	2	0	2	5	15
15	3	4	1	4	3	0	15
16	2	3	4	4	1	1	15
17	3	1	3	4	4	0	15
18	3	1	3	4	4	0	15
19	0	5	2	3	3	2	15
20	2	1	0	3	4	5	15
21	3	2	3	5	2	0	15
22	4	1	4	4	2	0	15
23	3	4	3	2	3	0	15
24	2	5	3	4	1	0	15
25	1	5	3	2	2	2	15
26	3	0	3	4	4	1	15
27	4	0	2	5	2	2	15
28	3	1	4	4	3	0	15
29	3	1	1	2	4	4	15
30	3	0	4	2	3	3	15

Table 3. Rating Recapitulation with NASA-TLX

Operator	Indicator Rating						Total
	MD	PD	TD	OP	EF	FR	
1	50	70	70	90	80	30	390
2	50	60	80	80	80	40	390
3	50	80	60	90	80	30	390
4	60	80	70	90	70	30	400
5	50	80	90	90	80	60	450
6	90	100	100	90	80	50	510
7	50	100	60	100	95	60	465
8	80	100	80	90	90	100	540
9	80	100	80	90	90	100	540
10	90	90	80	100	100	100	560
11	90	90	80	100	80	100	540
12	90	100	90	100	100	90	570
13	80	70	90	90	60	90	480
14	60	50	70	65	55	50	350
15	50	50	50	90	50	50	340
16	90	90	90	100	100	50	520
17	50	50	50	70	70	50	340
18	50	50	50	70	70	50	340
19	90	60	90	90	70	50	450
20	80	70	70	80	80	80	460
21	90	70	70	80	80	70	460
22	80	60	80	100	50	50	420
23	70	80	70	100	70	0	390
24	80	80	50	80	100	90	480
25	70	20	40	50	50	60	290
26	80	70	80	80	40	70	420
27	80	45	80	80	50	40	375
28	85	65	85	85	85	75	480
29	70	50	80	90	90	80	460
30	90	40	90	80	90	90	480

2. Rating Recapitulation with NASA-TLX. The recapitulation of NASA-TLX indicator ratings was carried out by assigning a score to six indicators using a scale of 0–100 (0 being considered low, 100 being considered high). The rating recap data is presented in Table 3.
3. Calculation of Product Value and Weighted Workload (WWL). The product value for each indicator was calculated for each worker. The

Table 4. Calculation of Product Value and Weighted Workload (WWL)

Operator	Product Value Indicator						WWL
	MD	PD	TD	OP	EF	FR	
1	200	0	140	270	80	150	840
2	150	0	160	240	160	200	910
3	150	0	120	270	160	150	850
4	180	0	140	270	140	150	880
5	0	160	180	180	320	300	1140
6	180	500	300	90	160	100	1330
7	250	0	180	200	190	180	1000
8	320	0	160	270	270	300	1320
9	320	0	160	270	180	400	1330
10	90	270	160	200	200	500	1420
11	90	270	160	200	160	500	1380
12	90	500	270	200	200	180	1440
13	400	70	270	360	120	0	1220
14	120	200	140	0	110	250	820
15	150	200	50	360	150	0	910
16	180	270	360	400	100	50	1360
17	150	50	150	280	280	0	910
18	150	50	150	280	280	0	910
19	0	300	180	270	210	100	1060
20	160	70	0	240	320	400	1190
21	270	140	210	400	160	0	1180
22	320	60	320	400	100	0	1200
23	210	320	210	200	210	0	1150
24	160	400	150	320	100	0	1130
25	350	0	160	150	100	60	820
26	240	0	240	320	160	70	1030
27	320	0	160	400	100	80	1060
28	255	65	340	340	255	0	1255
29	210	50	80	180	360	320	1200
30	270	0	360	160	270	270	1330

product value was obtained by multiplying the rating by the weight factor for each indicator and summing the six product values. Then, the WWL was calculated based on the recapitulation of the obtained product values. The calculation of product values and WWL is shown in Table 4.

4. Calculation and Interpretation of NASA-TLX Score. The NASA-TLX score was calculated by dividing the WWL by the number of indicator comparison pairs, which is 15 pairs. The score was then interpreted based on the workload category. The calculation of the NASA-TLX score and its interpretation is presented in Table 5.

Table 4. Calculation of Product Value and Weighted Workload (WWL)

Operator	Product Value Indicator						WWL
	MD	PD	TD	OP	EF	FR	
1	200	0	140	270	80	150	840
2	150	0	160	240	160	200	910
3	150	0	120	270	160	150	850
4	180	0	140	270	140	150	880
5	0	160	180	180	320	300	1140
6	180	500	300	90	160	100	1330
7	250	0	180	200	190	180	1000
8	320	0	160	270	270	300	1320
9	320	0	160	270	180	400	1330
10	90	270	160	200	200	500	1420
11	90	270	160	200	160	500	1380
12	90	500	270	200	200	180	1440
13	400	70	270	360	120	0	1220
14	120	200	140	0	110	250	820
15	150	200	50	360	150	0	910
16	180	270	360	400	100	50	1360
17	150	50	150	280	280	0	910
18	150	50	150	280	280	0	910
19	0	300	180	270	210	100	1060
20	160	70	0	240	320	400	1190
21	270	140	210	400	160	0	1180
22	320	60	320	400	100	0	1200
23	210	320	210	200	210	0	1150
24	160	400	150	320	100	0	1130
25	350	0	160	150	100	60	820
26	240	0	240	320	160	70	1030
27	320	0	160	400	100	80	1060
28	255	65	340	340	255	0	1255
29	210	50	80	180	360	320	1200
30	270	0	360	160	270	270	1330

Analysis of Result

Based on the calculation results, differences in scores can be seen between one worker and another. This difference occurs because the assessment conducted using the NASA-TLX method is subjective, depending on each worker's perception. After processing the data, as shown in Table 5, the highest and lowest NASA-TLX scores are 96.00 and 54.67, respectively. The mental workload of workers in the Liquid and Solid Production Divisions at PT Sanbe Farma Unit I is classified as high. This is caused by several factors, including the time pressure to complete tasks, as production targets must be met on time. In addition, workers are required to perform physical tasks such as lifting and pushing drums of pharmaceutical ingredients, as well as repairing production machines when the machine's

Table 5. Calculation and Interpretation of NASA – TLX Scores

Operator	NASA – TLX Score	Intepretations	Operator	NASA – TLX Sore	Interpretation
1	56	High	16	90,67	Very High
2	60,67	High	17	60,67	High
3	56,67	High	18	60,67	High
4	58,67	High	19	70,67	High
5	76	High	20	79,33	High
6	88,67	Very High	21	78,67	High
7	66,67	High	22	80	Very High
8	88	Very High	23	76,67	High
9	88,67	Very High	24	75,33	High
10	94,67	Very High	25	54,67	High
11	92	Very High	26	68,67	High
12	96	Very High	27	70,67	High
13	81,33	Very High	28	83,67	Very High
14	54,67	High	29	80,00	Very High
15	60,67	High	30	88,67	Very High

productivity in producing medicine is deemed slow. The recording of Overall Equipment Effectiveness (OEE) for machines and the progress of production in generating a product is still done manually.

The supervisor provides the machine OEE document or the status of the drug being produced to the workers, and the workers fill it out while monitoring the production process, which naturally results in a relatively high rate of human error. The high mental workload is also caused by the fact that the facilities or equipment available have not yet been optimally integrated with the system, resulting in coordination errors between departments at PT Sanbe Farma Unit I. Therefore, to reduce the mental and time burden on workers, periodic breaks of 5–15 minutes every hour can be implemented to help improve workers' focus. In addition, to alleviate the very high mental workload, adequate rest is necessary for example, by adding approximately 15 minutes to the previous 30-minute break time to allow for rest and prayer, ensuring that workers do not feel overburdened during work and that their prayer time is not disrupted (Pradhana et al., 2018). This addition is also in line with the minimum rest period requirements of 30 minutes as stipulated in Kementerian Ketenagakerjaan Republik Indonesia, UU Ketenagakerjaan No. 13 Tahun 2003.

Furthermore, based on the average workload of workers, as shown in Figure 1, it can be seen that the Own Performance indicator has a high average score. This is because workers are required to always meet the predetermined targets in their work. In production, the Liquid and Solid Product Divisions produce large-sized products that are related to human consumption, so workers must have high accuracy in the production process to ensure that the products are perfect.

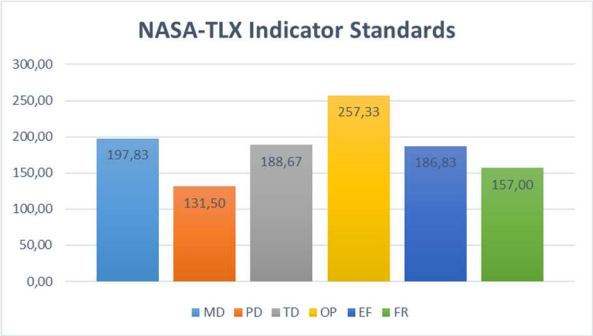

Figure 1. Average NASA-TLX Indicator

For the Mental Demand indicator, the high workload is due to the fact that workers must remember the amount of production completed, weigh the medicine according to specifications, record it in the production logbook, and sort defective products. Then, for the Physical Demand indicator, the high workload is due to physical

tasks such as lifting drums and pushing raw materials using a goods trolley.

For the Temporal Demand indicator, the high burden is caused by time pressure in the production process, which must meet targets, combined with the fact that the production floor systems are not yet integrated. For the Effort indicator, this is due to the extra effort workers must exert to complete their tasks, such as finding ways to ensure the machines produce medicine according to specifications. Lastly, for the Frustration Level indicator, the high workload is due to frequent coordination errors between departments, which often leads to mistakes.

IV. CONCLUSION

Based on the data processing and analysis conducted on the mental workload experienced by workers, it can be concluded that the indicator with the highest NASA-TLX score is Own Performance. This is due to several factors such as production targets that must meet the set standards, the large size of the products, and human interaction. Additionally, factors influencing workers' mental workload include production targets that must be completed within a certain time limit, manual record-keeping for manufactured goods, active machinery, and the current production being worked on. Workers have a high workload because they have to perform physical tasks such as lifting drums and pushing raw materials using a hand truck.

Then workers often experience coordination errors between departments, leading to frequent mistakes due to the lack of an integrated system. To reduce the extremely high mental load, sufficient rest is required, with a minimum of 30 minutes.

V. ACKNOWLEDGEMENT

The author would like to express gratitude to the Industrial Engineering Study Program, Telkom University, Purwokerto Campus, for their support throughout this research and publication project.

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