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Analysis Of Mental Workload Using Nasa-Tlx In Operational Employees At Pt X

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Abstract

Operational activities in logistics companies involve various tasks, including shipping and handling goods, which may increase employees' mental demands. At PT X, rising shipment volumes have intensified daily operations, highlighting the need to assess employees' mental workload. This study aims to evaluate mental workload levels, identify the most dominant NASA-TLX dimensions, and formulate improvement recommendations. A descriptive quantitative approach was employed using the NASA-TLX, involving all five operational employees: three couriers and two unloading personnel. The results showed workload scores ranging from 68.00 to 91.00, with an average of 81.33, classified as very high. Three employees (60%) experienced very high workloads, while two (40%) were in the high category. Temporal Demand recorded the highest weighted score of 1,585, followed by Effort (1,405) and Mental Demand (1,075). These findings highlight time-related demands as the most prominent workload dimension. Recommended improvements include work prioritization, staffing evaluation, material handling equipment, better employee coordination, and periodic mental workload assessments using the NASA-TLX method.

Keywords: Mental Workload, NASA-TLX, Operational Employees.

INTRODUCTION

The logistics industry plays an important role in supporting goods distribution and economic activities in Indonesia. However, its development has fluctuated over the years. According to Statistics Indonesia (BPS, 2026), the growth of the warehousing, transportation support services, postal, and courier subsectors declined to -17.61% in 2020, increased to 40.54% in 2022, and subsequently slowed to 17.91% in 2023 and 9.37% in 2024. These fluctuations require logistics companies to maintain effective operations amid changing business conditions.

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PT X is a logistics service company providing goods delivery through land, air, and sea transportation. Its operational activities are supported by five employees, consisting of three couriers and two unloading staff. The increasing operational demands are reflected in the number of goods handled, which increased from 54,582 units in 2023 to 66,824 units in 2024, and reached 86,364 units in 2025. The total weight of goods also increased from 850,901 kg in 2023 to 1,115,762 kg in 2024, and further increased to 1,132,551 kg in 2025. In 2025, relatively high levels of goods handling activity occurred in March, June, and December, when employees required additional working hours beyond their normal eight-hour workday. The details are presented in Table 1.

Table 1. Additional Working Hours of PT X Operational Employees in 2025

Employee	Normal Working Hours (Hours/Day)	March (Hours)	June (Hours)	December (Hours)
Courier 1	8	12	14	10
Courier 2	8	10	12	8
Courier 3	8	11	13	8
Unloading 1	8	9	10	10
Unloading 2	8	13	14	11
Total		**55**	**63**	**47**

Source: Internal Data of PT X, 2026

Based on Table 1, the accumulated additional working hours among the five operational employees reached 55 hours in March, 63 hours in June, and 47 hours in December 2025. This indicates that employees required additional time beyond their normal working hours to complete operational tasks during periods of high activity. If this condition persists, prolonged additional working hours may lead to stress, fatigue, reduced concentration, and decreased physical fitness among employees (Aliefarrafi et al., 2026).

Interviews revealed that couriers experienced time pressure when delivering goods to multiple destinations within the applicable Service Level Agreement (SLA), particularly due to traffic congestion and long distances. Meanwhile, unloading staff faced difficulties when incoming goods accumulated before previous goods had been completely handled, requiring additional effort to move and arrange heavy or large-sized goods. Employees also reported difficulties prioritizing accumulated tasks, while couriers sometimes assisted unloading activities when handling backlogs. These conditions indicate that operational activities involve physical demands as well as mental demands related to concentration, time management, and decision-making.

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Previous studies have examined mental workload in logistics and warehousing using NASA-TLX. Santoso and Kusnadi (2024) reported a high average Weighted Workload (WWL) score of 66.22 among logistics employees, with Own Performance as the dominant dimension. Similarly, Ali et al. (2024) found an average WWL score of 74.04 among warehouse employees at PT Pupuk Kujang Cikampek. However, these studies focused on specific logistics or warehouse settings, whereas this study examines couriers and unloading staff within the same company. This provides an opportunity to assess mental workload among employees with different operational responsibilities.

Despite these previous studies, PT X has not formally assessed the mental workload of its operational employees. Consequently, the workload level and dominant dimensions experienced by these employees remain unidentified. This study uses NASA-TLX, which evaluates mental workload through six dimensions: Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, and Frustration Level. The assessment aims to determine employees' mental workload levels, identify the dominant dimension, and formulate improvement recommendations based on the findings.

OBJECTIVES

This study aims to assess the mental workload of operational employees at PT X using the NASA-TLX method. Specifically, this study seeks to:

Determine the mental workload level of operational employees at PT X.

Identify the most dominant dimension contributing to the mental workload of operational employees.

Develop improvement recommendations based on the mental workload measurement results and existing operational working conditions.

This study contributes to mental workload assessment in logistics operations by examining couriers and unloading staff with different job responsibilities within the same company. The findings are expected to provide practical insights for PT X in evaluating work arrangements and improving operational processes.

LITERATURE REVIEW

Workload Analysis

Workload describes the tasks and responsibilities that an individual must handle within a certain period, which may require physical, mental, and emotional effort (Irawati & Arfy, 2025). An imbalance in workload may affect employee productivity, well-being, and health.

Workload analysis is necessary to identify the amount of work assigned to employees and prevent excessive work-related stress. Workload analysis is defined as a process of determining the number of working hours required, utilized, and allocated to

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human resources to complete a particular job within a specified period (Koesomowidjojo, 2021).

Workload Aspects

According to Koesomowidjojo (2021), workload consists of three aspects:

Physical Workload, which refers to workload assessment based on employees' physical conditions and capabilities. It includes physiological aspects, such as bodily functions and heart rate, as well as biomechanical aspects, such as muscle strength.

Mental Workload, which refers to workload assessment that considers employees' psychological conditions that may affect work quality and quantity. Mental workload can be measured through subjective assessment, performance measurement, psychophysiological measurement, and task analysis.

Time Utilization, which refers to workload assessment based on how employees allocate their working time. This aspect includes repetitive and non-repetitive tasks.

Subjective Mental Workload Measurement

Subjective mental workload measurement refers to an assessment of mental workload based on the perceptions of respondents or workers (Widyanti et al., 2010). Several methods can be used to measure subjective mental workload, including the National Aeronautics and Space Administration Task Load Index (NASA-TLX), Subjective Workload Assessment Technique (SWAT), Modified Cooper-Harper Scale, Multidimensional Scale, and Rating Scale Mental Effort (RSME).

The general stages of subjective mental workload measurement include:

1. Identifying the mental workload factors associated with the tasks being assessed.
2. Determining the measurement range and interval values.
3. Selecting the workload factors that are most relevant to specific tasks.
4. Identifying subjective factors that may influence workload assessment.

NASA-TLX

The NASA Task Load Index (NASA-TLX) is a subjective mental workload measurement method developed by Sandra G. Hart and Lowell E. Staveland to assess perceived workload through several dimensions (Maarif & Kartika, 2023). The method consists of six dimensions:

1. Mental Demand (MD) refers to the level of mental activity required to complete a task, such as thinking, remembering, concentrating, and making decisions.

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2. Physical Demand (PD) refers to the level of physical activity required to perform a task, such as lifting, pushing, pulling, and other physical movements.
3. Temporal Demand (TD) refers to the perceived time pressure associated with the time available to complete tasks and meet deadlines.
4. Performance (P) refers to employees' perceived level of success in completing tasks and the satisfaction they experience with their work performance.
5. Effort (E) refers to the amount of mental and physical effort required to achieve a certain level of performance.
6. Frustration Level (FL) refers to the degree of frustration, stress, insecurity, or discomfort experienced by employees while performing their tasks.

RESEARCH METHOD

This study used a descriptive quantitative method to identify the mental workload experienced by operational employees at PT X through the NASA Task Load Index (NASA-TLX). The respondents were all five operational employees, consisting of three couriers and two unloading staff. Saturated sampling was applied because the study involved the entire population.

The data consisted of primary and secondary sources. Primary data were obtained through interviews with the branch manager and operational employees, as well as questionnaires based on the NASA-TLX method. Secondary data were collected from company records, including employee information, the number of goods handled from 2023 to 2025, and working-hour records. Books, scientific journals, and previous studies were also used as supporting references. Data were collected through interviews, documentation, questionnaires, and literature reviews.

The research instrument was tested for validity and reliability using SPSS version 27. Before the NASA-TLX assessment, data uniformity and sufficiency tests were conducted to ensure that the collected data met the required criteria. Mental workload was measured through six dimensions: Mental Demand (MD), Physical Demand (PD), Temporal Demand (TD), Performance (P), Effort (E), and Frustration Level (FL). The assessment consisted of weighting and rating stages. Respondents completed 15 pairwise comparisons to determine the weight of each dimension and provided ratings on a scale of 0–100. Each dimension's weight was multiplied by its rating to obtain the product score. The six product scores were summed to calculate the Weighted Workload (WWL), which was then divided by 15 to obtain the final NASA-TLX score. The scores were classified into five categories: very low (0–20), low (21–40), moderate (41–60), high (61–80), and very high (81–100). The dominant dimension was identified based on the highest total product score.

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RESULT

Respondent Characteristics

Table 2. Respondent Characteristics

Code	Position	Gender	Age	Length of Service
R1	Courier	Male	26 years	3 years
R2	Courier	Male	39 years	6 years
R3	Courier	Male	35 years	1 year 4 months
R4	Unloading	Male	47 years	6 years
R5	Unloading	Male	28 years	3 months

Source: Processed by the Authors, 2026

Validitas Test

Table 3. Validity Test Results

Dimension	r-count	r-table	sig. (2-tailed)	Conclusion
MD	0.947	0.878	0.015	Valid
PD	0.891	0.878	0.043	Valid
TD	0.889	0.878	0.044	Valid
P	0.900	0.878	0.037	Valid
E	0.912	0.878	0.031	Valid
FL	0.898	0.878	0.039	Valid

Source: SPSS Output, Processed by the Authors, 2026

The validity test results show that all six NASA-TLX dimensions have r-count values greater than the r-table value of 0.878 and significance values below 0.05. Therefore, all dimensions meet the validity criteria applied in this study.

Reliability Test

Table 4. Reliability Test Results

Cronbach's Alpha	Minimum Criterion	Number of Items	conclusion
0.943	0.70	6	Reliable

Source: SPSS Output, Processed by the Authors, 2026

The instrument was considered reliable, as the Cronbach's Alpha value reached 0.943, which is higher than the required threshold of 0.70.

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Data Uniformity Test

Table 5. Data Uniformity Test Results

Respondent	Questionnaire Data	$\underline{X}$	σ	BKA	BKB
R1	420	474	58.14	648.42	299.58
R2	535	474	58.14	648.42	299.58
R3	495	474	58.14	648.42	299.58
R4	515	474	58.14	648.42	299.58
R5	405	474	58.14	648.42	299.58

Source: Processed by the Authors, 2026

The data uniformity test shows that all five respondents' scores fall within the upper control limit (648.42) and lower control limit (299.58). Therefore, the data are considered uniform.

Data Sufficiency Test

Table 6. Data Sufficiency Test Results

Description	Value
Actual Sample Size (N)	5
Required Sample Size (N')	4.81
Conclusion	Sufficient

Source: Processed by the Authors, 2026

The data sufficiency test resulted in a required sample size (N') of 4.81, which is lower than the actual sample size (N) of 5. Therefore, the number of collected observations meets the data sufficiency criterion.

NASA-TLX Measurement

Table 7. NASA-TLX Measurement Results

Respondent	Dimension	Weight	Rating	Product (Weight × Rating)	WWL	Score	Workload Classification
R1	MD	3	75	225	1.100	73.33	High
	PD	1	60	60			
	TD	5	80	400			
	P	2	60	120			
	E	3	75	225			
	FL	1	70	70			

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R2	MD	2	90	180	1.365	91.00	Very High
	PD	2	85	170			
	TD	4	90	360			
	P	1	85	85			
	E	4	100	400			
	FL	2	85	170			
R3	MD	4	90	360	1.280	85.53	Very High
	PD	2	85	170			
	TD	4	90	360			
	P	1	70	70			
	E	3	80	240			
	FL	1	80	80			
R4	MD	2	90	180	1.335	89.00	Very HIgh
	PD	3	85	255			
	TD	3	90	270			
	P	1	70	70			
	E	4	100	400			
	FL	2	80	160			
R5	MD	2	65	130	1.020	68.00	High
	PD	3	70	210			
	TD	3	65	195			
	P	2	60	120			
	E	2	70	140			
	FL	3	75	225			

Source: Processed by the Authors, 2026

The NASA-TLX measurement results show that the respondents' mental workload scores ranged from 68.00 to 91.00, with an average score of 81.33, which falls into the very high category.

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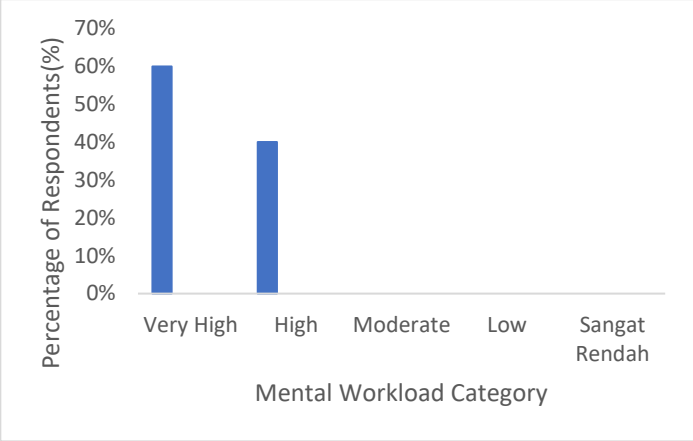

Figure 1. Distribution of Respondents by Mental Workload Category

Figure 1 shows that 60% of respondents (3 employees) experienced a very high level of mental workload, while the remaining 40% (2 employees) experienced a high level. These results indicate that all operational employees involved in this study experienced relatively high mental workload, with the majority falling into the very high category.

DISCUSSION

The NASA-TLX measurement results show that the average mental workload score of PT X operational employees was 81.33, which falls into the very high category. Three respondents (60%) experienced a very high level of mental workload, while two respondents (40%) were classified in the high category. Among the five respondents, R2, a courier, obtained the highest score of 91.00, with a Weighted Workload (WWL) of 1,365. The highest contributing dimension was Effort (400), followed by Temporal Demand (360). This indicates that the respondent needed considerable effort to complete delivery tasks while facing time constraints. R4, an unloading staff member, recorded the second-highest score of 89.00, with a WWL of 1,335. Effort was also the dominant dimension (400), followed by Temporal Demand (270) and Physical Demand (255), reflecting the physical effort required to handle and move incoming goods.

R3, a courier, obtained a score of 85.33, with a WWL of 1,280. Mental Demand and Temporal Demand were the dominant dimensions, each contributing 360. This result is related to the need to concentrate on shipment information, delivery addresses, and routes while completing deliveries within the available time. R1, also a courier, obtained a score of 73.33, with a WWL of 1,100. Temporal Demand was the dominant dimension (400), indicating that time pressure was the main workload factor for this respondent. Meanwhile, R5, an unloading staff member, recorded the lowest score of 68.00, with a WWL of 1,020. Frustration Level was the dominant dimension (225), followed by Physical

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Demand (210) and Temporal Demand (195). This suggests that difficulties during work, physical demands, and accumulated tasks may contribute to the respondent's workload.

Table 8. Dominant Mental Workload Dimensions Based on NASA-TLX

Mental Workload Dimension	Total Product Score	Rank
Temporal Demand (TD)	1.585	1
Effort (E)	1.405	2
Mental Demand (MD)	1.075	3
Physical Demand (PD)	865	4
Frustration Level (FL)	705	5
Performance (P)	465	6

Source: Processed by the Authors, 2026

Based on Table 8, Temporal Demand (TD) was the most dominant dimension, with a total product score of 1,585. This was followed by Effort (E) with 1,405 and Mental Demand (MD) with 1,075. The dominance of Temporal Demand indicates that time pressure was the main contributor to employees' mental workload. This condition is reflected in the couriers' responsibilities to deliver goods to multiple destinations within the applicable Service Level Agreement (SLA). Traffic congestion, long distances, and the time required at each delivery location may affect the completion of subsequent deliveries. Meanwhile, unloading staff must handle incoming goods while ensuring that previously received goods are processed. When the volume of goods increases, unfinished tasks may accumulate and extend working activities beyond normal working hours.

Effort ranked second, indicating that employees also experienced considerable demands in completing their tasks. Couriers had to load, arrange, and unload goods, while unloading staff repeatedly lifted, carried, and arranged incoming goods, including heavy items such as spare parts and towing equipment. These activities were mainly performed manually and required repeated physical movements. Couriers also sometimes assisted unloading activities when goods accumulated. This finding is consistent with Mixter et al. (2022), who explain that physical and cognitive demands can occur simultaneously during work activities.

Mental Demand ranked third, reflecting the concentration required to complete operational tasks. Couriers needed to pay attention to shipment information, delivery addresses, and routes. Unclear addresses or similar street names required additional verification. Meanwhile, unloading staff needed to identify the size and shape of goods and determine appropriate handling methods to avoid errors.

Although Physical Demand ranked fourth with a score of 865, physical activities remained an important part of employees' responsibilities, particularly for unloading staff

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who repeatedly lifted and moved goods. Handling heavy items without adequate material-handling equipment could contribute to physical fatigue. Hasanah et al. (2025) explain that excessive physical workload may cause fatigue, reduce work quality, and increase the risk of workplace accidents.

Frustration Level ranked fifth, with a score of 705, and was associated with difficulties such as unclear delivery addresses, recipients who could not be contacted, and accumulated incoming goods. Performance obtained the lowest score of 465, indicating a smaller contribution to the overall workload compared with the other dimensions.

Based on the NASA-TLX results and interviews, several improvement efforts are proposed to manage the mental workload of operational employees at PT X. First, the company should establish a daily work-priority system. This recommendation is based on Temporal Demand (TD), which obtained the highest total product score of 1,585. Interviews revealed that the company had not implemented a specific system for prioritizing daily tasks. Therefore, the branch manager should coordinate daily task lists containing delivery deadlines, shipment quantities, and task completion status.

Second, the company needs to review its workforce requirements and task allocation. This is necessary considering that the average mental workload score reached 81.33, placing it in the very high category. The review should take into account the volume of goods handled, the time required to complete tasks, pending work, and additional working hours. If tasks remain unfinished within normal working hours despite adjustments to task distribution, the company may consider recruiting additional employees. As an initial illustration, a staffing simulation can be calculated based on the average mental workload score of each section using the following formula:

$$\bar{x} = \frac{Total\ Mental\ Workload\ Score}{Number\ of\ Employees}$$

a) Courier Section

Total mental workload score $= 73.33 + 91.00 + 85.33 = 249.66$

Current condition (3 employees) $= \frac{249.66}{3} = 83.22$ (Very High)

Adding 2 employees (5 employees) $= \frac{249.66}{3+2} = \frac{249.66}{5} = 49.93$ (Moderate)

b) Unloading Section

Total mental workload score $= 89.00 + 68.00 = 157.00$

Current condition (3 employees) $= \frac{157.00}{2} = 78.50$ (Very High)

Adding 2 employees (5 employees) $= \frac{157.00}{2+1} = \frac{157.00}{3} = 52.33$ (Moderate)

Third, the company should provide appropriate material-handling equipment to support unloading activities. This recommendation is related to Effort (E), which obtained

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the second-highest total product score of 1,405. Interviews indicated that employees still move goods manually, including large and heavy items. The company could provide a platform trolley, hand pallet, or forklift according to the size and weight of the goods. Therefore, providing suitable equipment is expected to reduce physical effort and support safer operational activities.

Fourth, employee coordination and support should be improved through brief daily meetings to discuss shipment volumes, work priorities, task responsibilities, and operational constraints. The branch manager can also arrange assistance between couriers and unloading staff when necessary, while ensuring that their primary responsibilities are not disrupted.

Finally, the company should conduct periodic mental workload assessments using NASA-TLX. Since all respondents experienced high or very high workload levels, reassessment every six months is recommended to monitor changes and evaluate the effectiveness of improvement efforts. The same NASA-TLX procedures should be applied to ensure consistent comparisons between assessment periods.

CONCLUSION

The NASA-TLX results indicated an average mental workload score of 81.33 for the operational employees of PT X, which is classified as very high. The scores ranged from 68.00 to 91.00, with three respondents (60%) classified in the very high category and two respondents (40%) in the high category. Temporal Demand (TD) was the most dominant dimension, with a total product score of 1,585, followed by Effort (E) at 1,405 and Mental Demand (MD) at 1,075. Meanwhile, Physical Demand (PD), Frustration Level (FL), and Performance (P) obtained scores of 865, 705, and 465, respectively. The dominant dimensions varied among respondents, reflecting differences in workload experiences according to their job responsibilities.

Based on these findings, several improvement efforts are proposed, including establishing daily work priorities, evaluating workforce requirements and task distribution, providing material-handling equipment, improving employee coordination, and conducting mental workload assessments every six months using NASA-TLX. These efforts are expected to help the company manage operational demands and pay greater attention to employees' mental workload.

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