Indonesian Journal of Engineering, Science and Technology
IJENSET
Volume 02 – Issue 02, December 2025
e-ISSN: 3089-2392
Journal Link: https://jurnal.umla.ac.id/index.php/ijenset/index

ANALYSIS OF WORKLOAD OF CIRENG PRODUCTION WORKERS USING THE NASA-TLX METHOD AT UD. MITRA ABADI MADURAN

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Article Information

Submitted	:	November, 27 2025
Revised	:	December, 2 2025
Accepted	:	December, 16 2025
Paper page	:	66-76
DOI	:	10.38040/ijenset.v2i2.1384

ABSTRACT

This study aims to analyze the workload experienced by workers in the production of snow cireng and chicken-filled cireng at UD Mitra Abadi, Duriwetan Village, Maduran Subdistrict, Lamongan. The production process involves high physical and mental demands, especially in activities such as manually mixing dough, shaping dough, lifting raw materials, and performing packaging. The NASA Task Load Index (NASA-TLX) method is used to measure perceived workload based on six dimensions, namely mental demand, physical demand, time pressure, effort, level of success, and level of frustration. Data collection was obtained through observation, interviews, and distributing questionnaires to workers. The results of the study show that the workers' workload level falls into the high category, with the indicators most influencing the workload being Effort (27.50%) and Physical Demand (22.50%), which indicates that production activities require significant physical effort and are performed repeatedly, making it the most dominant factor causing fatigue. Some workers also complain of discomfort in the back, shoulders, and arms due to manual work and less ergonomic working postures. Recommended improvements include adding male workers so tasks do not overlap and the workload is reduced, as well as adding automatic mixing machines to decrease physical fatigue. The use of PPE such as heat-resistant gloves should be mandatory, and the layout and height of worktables need to be adjusted to be more ergonomic and reduce physical complaints.

Keywords— *Workload; NASA-TLX Method; Ergonomics.*

I. INTRODUCTION

UD. Mitra Abadi is a company engaged in the meat processing and preservation industry under the brand name Horizon. The products produced include fish nuggets, fish meatballs, snow cireng, chicken-filled cireng, and various types of dim sum. The company is

located in Duriwetan Village, Maduran District, Lamongan Regency.

Workload is the demand of tasks assigned to employees that must be completed within a certain period in a company (Vania et al., 2022)**.** Employees are the main asset of a company, because without their involvement, company activities would not take place (Fahlevi & Chalil, 2024). Mental workload is defined as the assessment of the limit of attention load when performing tasks, influenced by task demands and individual capacity (Octaviaji et al., 2024). Physical workload is the workload determined by the worker's physical activities and is directly related to the use of body energy (Mangowal et al., 2023)**.**

In the production process at UD. Mitra Abadi, particularly in the snow cireng and chicken-filled cireng sections, there is an imbalance in the workload. For example, if male workers in the cireng production section are absent or do not come to work, workers from other sections, such as fish nugget production, have to assist with the tasks of making chicken-filled cireng and snow cireng. This results in overlapping work and decreased work efficiency. It is noted that there are 5 male workers and 15 female workers in the cireng production section. In addition, workers experience cramps in their backs, hands, and shoulders while working, due to the arrangement and height of the chairs/desks being uncomfortable.

This inequality affects physical and mental fatigue, especially among male workers because they are required to perform tasks such as manually stirring dough, shaping, and packaging. Meanwhile, female workers are responsible for tasks such as peeling garlic, shaping, and packaging products.

In addition to fatigue, an imbalanced work condition and high physical effort also increase the risk of injury or accidents. According to (Darwis et al., 2020), injury is defined as a wound or physical harm experienced by workers during work, such as a cut on the hand or finger due to work activities. A work accident is an unexpected and undesired event that can cause property damage, injuries, disability, or death, and occurs within the context of the work relationship (Nahuri et al., 2023).

Imbalance in mental workload can trigger stress or feelings of frustration, which ultimately negatively affect productivity, reduce work quality, and can increase the likelihood of work accidents (Yuliana et al., 2021).

This is evidenced by the incident of a worker's finger being caught in the machine during the process of printing chicken-filled cireng dough, which occurred due to fatigue and decreased concentration of the worker while working. To understand the level of workload experienced by workers and the factors that most influence it. Therefore, a structured assessment method is needed to evaluate the level of mental workload more objectively (Andivas et al., 2023).

This study uses the NASA-TLX method. This method assesses workload based on six dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration level. NASA-TLX was chosen because it can provide a quantification of workload based on ratings from these six indicators (Ramdani et al., 2025). It also provides a comprehensive overview of workers' workload perceptions and has been used in various industrial contexts, including small-scale food industries, which is relevant to the situation at UD Mitra Abadi.

II. METHOD

A. Research Object

The focus of this study is on the extent of the workload perceived by workers in the production section of chicken-filled cireng and snow cireng at UD. Mitra Abadi. Physical or

mental workload is the focus of the research, which is used as a reference by the researcher to determine the optimal workload required for workers in the production section and to identify issues related to physical/mental workload in the production of chicken-filled cireng and snow cireng at UD. Mitra Abadi. Workload measurement in this study uses the NASA-TLX method to determine physical/mental workload. The primary data source for this research is obtained through filling out questionnaires, which will be explained in more detail in the stage of assessing mental workload using the NASA-TLX method (Nurbaiti et al., 2021).

B. Data Collection

To support the smooth implementation of the internship, data collection was carried out systematically so that the research activities could proceed as planned and be completed on time. This study uses primary data, which was collected through the distribution of questionnaires, interviews, and direct observations of work (Hariansyah, 2022). Observations were conducted to understand the working conditions directly, while the NASA-TLX (National Aeronautics and Space Administration Task Load Index) questionnaire was targeted at workers in the production section of chicken-filled cireng and snow cireng at UD. Mitra Abadi. The data collection aimed to identify aspects of physical and mental workload experienced by workers while performing their tasks.

C. NASA-TLX Method

The NASA Task Load Index (NASA-TLX) is a subjective method developed by NASA to measure a person's mental workload in completing tasks. This method has the advantages of being multidimensional, having tested validity and reliability, flexibility in various contexts, and sensitivity to changes in mental workload (Anggar Rizki Fadhilah, 2025). In another definition, NASA-TLX defines workload as the load in terms of the sources of demands imposed for different tasks (Hanissa Okitasari, 2020).

The method in NASA-TLX is based on the emergence of 9 factors, but it has been simplified to have 6 factors, namely Mental Demand, Physical Demand, Temporal Demand, Own Performance, Effort, and Frustration (anita pramesti, 2021). The steps for measurement using NASA-TLX are as follows: (Muhammad Alifian, 2023).

- The explanation of the mental workload indicators to be measured includes 6 NASA TLX indicators covering mental demand, physical demand, temporal demand, performance, effort, and frustration level.

- Weighting

Respondents were asked to choose one indicator from a comparison of two existing indicators that was felt to create a mental workload for the worker. From this questionnaire, the tally count for each indicator perceived as most influential was calculated. The tally count becomes the weight for each mental workload indicator.

- Giving a Rating

Next, respondents were asked to give a rating for the six mental workload indicators. This rating is subjective for each respondent depending on the mental workload they feel. To obtain the NASA-TLX mental workload score, the weights and ratings of each indicator are then summed and divided by 15 (the number of pairwise comparisons).

- Calculating the Product Value

Multiply the rating by the factor weight for each descriptor. This produces 6 product values for 6 indicators (MD, PD, TP, OP, FR, EF)

$$Product = Rating \times Factor\ Weight \quad (1)$$

- Calculating WWL

In this section, it is obtained by summing the six product values:

$$WWL = \sum Products \quad (2)$$

- Calculating the average WWL

In this section, it is obtained by dividing WWL by the total weight:

$$\text{Average WWL} = \frac{\sum Products}{15} \quad (3)$$

- Score Interpretation

In this section, the interpretation of the scores is carried out by categorizing the scores according to workload categories based on NASA-TLX as shown in Table 1.

Table 1. Workload Categories Based on NASA-TLX

Score	Rating
0 – 9	Low
10 – 29	Busy
30 – 49	Somewhat tall
50 – 79	Tall
80 – 100	very high

III. RESULTS AND DISCUSSION

A. Results of NASA-TLX Workload Processing

Workload calculations are carried out through the stages of weighting, giving ratings, calculating product values, calculating WWL, averaging WWL, and interpreting workload category scores. As follows:

- Weighting

  At the weighting stage, respondents were asked to choose one of the indicators (right or left) that most influences their workload. The following are the weighting results obtained from the workers' questionnaires:

Table 2. Weighting

No	Respondent Name	Gender	Age	Questionnaire Weighting						Total
				MD	PD	TD	OP	EF	FR	
1	Ahmad	L	19	1	4	2	1	2	5	15
2	Afif	L	26	2	3	2	1	5	2	15
3	Akwan	L	27	1	3	3	2	4	2	15
4	Rina	P	22	2	2	3	3	4	1	15
5	Torik	L	23	1	5	1	1	3	4	15
6	Nartik	P	44	2	3	3	2	5	0	15
7	Riyanto	L	35	2	4	2	1	5	1	15
8	Vidia	P	20	2	3	4	1	5	0	15

- Giving a Rating

  In the rating questionnaire, respondents were asked to give scores on six indicators by circling the scale that matched the conditions they experienced while working. The following are the rating data results from the workers' questionnaires:

Table 3. Giving a Rating

No	Respondent Name	Gender	Age	Questionnaire Weighting					
				MD	PD	TD	OP	EF	FR
1	Ahmad	L	19	80	100	60	80	90	30
2	Afif	L	26	90	100	70	90	100	50
3	Akwan	L	27	70	70	70	80	75	60
4	Rina	P	22	50	40	45	65	50	25
5	Torik	L	23	80	90	70	80	80	50
6	Nartik	P	44	50	35	50	85	40	25
7	Riyanto	L	35	90	90	60	90	85	75
8	Vidia	P	20	50	50	40	70	50	10

- Product Value Calculation
  Obtained by multiplying the rating by the factor weight for each respondent. Thus, 6 product values are produced for 6 indicators MD, PD, TD, OP, EF, FR. (product = rating x factor weight). The following are the results of the product value calculations:

Table 4. Product Value Calculation

No	Respondent Name	Gender	Age	Questionnaire Weighting					
				MD	PD	TD	OP	EF	FR
1	Ahmad	L	19	80	400	120	80	180	150
2	Afif	L	26	180	300	140	90	500	100
3	Akwan	L	27	70	210	210	160	300	120
4	Rina	P	22	100	80	135	195	200	25
5	Torik	L	23	80	450	70	80	240	200
6	Nartik	P	44	100	105	150	170	200	0
7	Riyanto	L	35	180	360	120	90	425	75
8	Vidia	P	20	100	150	160	70	250	0

- WWL Calculation
  The calculation of the Weighted Workload (WWL) value is obtained by summing the product of each indicator from each respondent. Here are the results of summing the six product values:

Table 5. WWL Calculation

No	Respondent Name	Gender	Age	Questionnaire Weighting						Total
				MD	PD	TD	OP	EF	FR	
1	Ahmad	L	19	80	400	120	80	180	150	1010
2	Afif	L	26	180	300	140	90	500	100	1310
3	Akwan	L	27	70	210	210	160	300	120	1070
4	Rina	P	22	100	80	135	195	200	25	735
5	Torik	L	23	80	450	70	80	240	200	1120
6	Nartik	P	44	100	105	150	170	200	0	725
7	Riyanto	L	35	180	360	120	90	425	75	1250
8	Vidia	P	20	100	150	160	70	250	0	730

- Average WWL
  Obtained by dividing the WWL by the total weight of 15, which is derived from the sum of pairwise comparisons between indicators. After the average WWL value is obtained, this value will then be totaled and the score interpreted based on the average WWL result. The following are the results of the WWL average calculation:

Table 6. Average WWL

No	Respondent Name	Gender	Age	Questionnaire Weighting						Total
				MD	PD	TD	OP	EF	FR	
1	Ahmad	L	19	5,33	26,66	8	5,33	12	10	67,32
2	Afif	L	26	12	20	9,33	6	33,33	6,66	87,32
3	Akwan	L	27	4,66	14	14	10,66	20	8	71,32
4	Rina	P	22	6,66	5,33	9	13	13,33	1,66	48,98
5	Torik	L	23	5,33	30	4,66	5,33	16	13,33	74,65
6	Nartik	P	44	6,66	7	10	11,33	13,33	0	48,32
7	Riyanto	L	35	12	24	8	6	28,33	5	83,33
8	Vidia	P	20	6,66	10	10,66	4,66	16,66	0	48,64

- Interpretation of Workload Scores /Categories
  After the average WWL value is obtained, an interpretation will be made based on the average WWL value. There are 5 category levels in the workload grouping as shown in Table 3.1. The following is a table of score interpretations according to the category from each worker in the production section of snow cireng and chicken-filled cireng at UD. Mitra Abadi:

Table 7. Mental Workload Score/Category

No	Respondent Name	Gender	Average WWL	Category Workload
1	Ahmad	L	67,32	Tall
2	Afif	L	87,32	Very High
3	Akwan	L	71,32	Tall
4	Rina	P	48,98	Somewhat tall
5	Torik	L	74,65	Tall
6	Nartik	P	48,32	Somewhat tall
7	Riyanto	L	83,33	Very High
8	Vidia	P	48,64	Somewhat tall

B. Analysis of Dominant Factors Causing Workload

From the results of mental workload using the NASA-TLX method on cireng production workers, the percentage of each mental workload indicator will then be calculated to determine which factors are the dominant causes of high workload for workers in the cireng production section. As shown in the following table:

Table 8. Total of All Selections of NASA-TLX Mental Workload Indicators

No	Respondent Name	Indicator					
		Mental Demand (MD)	Physical Demand (PD)	Temporal Demand (TD)	Own Performance (OP)	Effort (EF)	Frustration (FR)
1	Ahmad	1	4	2	1	2	5
2	Afif	2	3	2	1	5	2
3	Akwan	1	3	3	2	4	2
4	Rina	2	2	3	3	4	1
5	Torik	1	5	1	1	3	4
6	Nartik	2	3	3	2	5	0
7	Riyanto	2	4	2	1	5	1
8	Vidia	2	3	4	1	5	0
Total		**13**	**27**	**20**	**12**	**33**	**15**
Percentage		**10,8%**	**22,5%**	**16,7%**	**10%**	**27,5%**	**12,5%**

From the selection of mental workload indicators chosen by workers through a questionnaire, they will then be totaled according to the existing indicators, and then the total of all the indicators will be summed, so that the sum will become the divisor for each total indicator. Here is the calculation of the

percentage of mental workload results using the NASA-TLX method:

Example:

Total mental workload for each indicator (Mental Demand)

MD = 1 + 2 + 1 + 2 + 1 + 2 + 2 + 2 = 13

The results of all mental workload indicators that have been totaled.

Total Indicators = 13 + 27 + 20 + 12 + 33 + 15 = 120

The percentage of each mental workload indicator.

$$\text{Percentage} = \frac{\textit{Total workload of each indicator}}{\textit{The results of all mental workload indicators that have been totaled}} \times 100\%$$

$$= \frac{13}{120} \times 100\%$$

= 10,8 %

Using the calculation method above, the percentage of workload indicators that have the most influence is known, and the factors that are the dominant causes of the high workload of cireng production workers can be seen in Table 9. As follows:

Table 9. Workload Indicator Percentage

Indicator	Percentage (%)
Effort (EF)	27,50 %
Physical Demand (PD)	22,50 %
Temporal Demand (TD)	16,70 %
Mental Demand (MD)	10,80 %
Frustration (FR)	12,50 %
Own Performance (OP)	10 %

The indicator with the greatest influence is Effort (EF) at 27.50%, which indicates that workers require a high level of physical effort during the production process. This is influenced by the lack of male workers also performing activities such as manually mixing dough, carrying flour from downstairs to the second floor of the production area, and packaging.

The second largest indicator is Physical Demand (PD) at 22.50%, indicating that the work activities require significant physical strength and are performed repeatedly over a long period of time.

C. Worker Workload Categories

Overall, the average WWL of the workers is 66.12, which falls into the High category. Male workers tend to fall into the 'high' to 'very high' category because they handle heavy physical activities, while female workers fall into the 'moderately high' category.

These findings indicate a difference in workload among workers, where female workers mostly perform light tasks such as packaging and peeling onions, while male workers are responsible for heavy tasks such as manually mixing dough and up to the packaging process.

D. The Impact of Workload on Working Conditions

High workload directly impacts:

1. Physical fatigue: complaints in the back, hands, and shoulders
2. Decreased concentration: affecting product quality
3. Risk of accidents: one worker experienced a finger getting caught in the dough rolling machine
4. Decreased productivity: especially when male workers are absent

This aligns with ergonomic principles which state that repetitive activities, non-neutral working postures, and high physical

demands are factors that can trigger an increased risk of accidents.

E. Discussion

The results of the NASA-TLX assessment show that the workload of workers in the production section for cireng is in the high to very high category. Male workers have higher WWL values because they handle heavy physical tasks such as stirring the dough, lifting raw materials, molding, and packaging. Meanwhile, female workers fall into the somewhat high category because their tasks are lighter, such as peeling spices, molding, and packaging.

The indicators that contribute the most to workload are Effort (27.50%) and Physical Demand (22.50%), indicating that production activities require significant physical strength and are performed repeatedly. Fatigue due to high physical demands affects concentration and increases the risk of accidents, one of which is finger injuries caught in the dough rolling machine.

The average WWL value of 66.12 indicates that working conditions are still less ergonomic and uneven among workers. Therefore, improvements can be made through the use of assistive tools, adjustments to workstations, task rotation, and the addition of workers to heavy physical activities to make the workload more balanced.

IV. CONCLUSION

Based on the results of data collection and workload analysis using the NASA-TLX method on production workers of cireng at UD Mitra Abadi, several key conclusions were obtained. First, the level of mental workload of the workers falls into the high category, with details of two male respondents in the very high category, three male respondents in the high category, and three female respondents in the somewhat high category. This indicates an imbalance in workload between male and female workers, which affects physical fatigue and mental stress during the production process.

Second, the average Weighted Workload (WWL) value of 66.12 places the workers' workload in the high category. Indicator analysis shows that the Effort (EF) dimension at 27.50% is the dominant factor contributing to the increased workload, followed by Physical Demand (PD) at 22.50%. This indicates that workers exert significant physical effort and face heavy activity demands during the production process.

Third, the high workload, especially in terms of Effort and Physical Demand, impacts the decline in workplace safety. This condition triggers fatigue, decreased focus, and increases the risk of work accidents, as evidenced by the incident of a worker's finger being caught in a dough flattening machine during the production process of chicken-filled cireng.

Fourth, based on the overall analysis, the main recommendations include: adding male workers to balance task distribution, using automatic mixing machines to reduce physical strain, enforcing the use of PPE such as thick heat-resistant gloves, and adjusting the layout and height of work tables to meet ergonomic principles. These findings are expected to improve safety, comfort, and efficiency in the production process at UD Mitra Abadi.

Based on the processed data that has been analyzed, recommendations/suggestions for improvements are given to address the workload indicators that most influence Cireng production, namely at the business-level workload and physical workload, as well as other indicators, which are:

a. It is necessary to add male workers to avoid task overlap when a worker is absent, thereby reducing fatigue and excessive workload.
b. Investment in automatic mixing machines is needed to reduce physical strain, which can increase work efficiency/productivity and maintain product quality consistency.

c. Require workers to use personal protective equipment (PPE) such as thick heat-resistant gloves, especially when making dough and when using machines to shape chicken-stuffed cireng dough, to prevent workplace accidents.
d. Improvement of the layout and adjustment of the work desk height according to ergonomics to reduce pressure on the back, hands, and shoulders.

V. ACKNOWLEDGMENTS

The author expresses appreciation and gratitude to various parties who have assisted in this research process. Thanks are extended to Mr. Moh. Nasrudin, as the field supervisor and owner of UD Mitra Abadi, who has provided permission, support, and guidance during the practice work implementation. Gratitude is also conveyed to the colleagues in the cireng production section who have helped by providing data, information, and cooperation during the observation process and questionnaire completion.

Sincere appreciation is also extended to Mrs. Dianda Aryntya Firia Ferlania, S.T., M.T., as Head of the Study Program, and Mr. Islahuddin Abdullah, S.T., M.T., as the supervising lecturer, for their valuable guidance and direction throughout the preparation of this internship report. The author also thanks others who have assisted, whether through facilities, moral support, or feedback, during the implementation and writing of the report.

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