Contents Lists Available at: https://journal2.unusa.ac.id/
Medical Technology and Public Health Journal
Journal Home Page: https://journal2.unusa.ac.id/index.php/MTPHJ

Research Article

Examining Physical Workload and Manual Material Handling: A NIOSH Lifting Equation Analysis for Packing Workers at PT X

Rahadian Roro Siti Karimah[1*] | *Muslikha Nourma Rhomadhoni* [2*] |*Ratna Ayu Ratriwardhani*[3] | *Moch. Sahri*[4]

[1,2,3,4,5] *Department of Occupational Health and Safety, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, Indonesia*

***Corresponding Author**:
Muslikha Nourma Rhomadhoni, Department of Occupational Health and Safety, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, Indonesia.
Email: muslikhanourma@unusa.ac.id

DOI: *10.33086/mtphj.v7i2.4477*

Article History:
Received, June 12th, 2023
Revised, September 07th, 2023
Accepted, October 02nd, 2023
Available Online: October 24th, 2023

Please cite this article as:
Karimah, Rahardian R.S. et, al., "Examining Physical Workload and Manual Material Handling: A NIOSH Lifting Equation Analysis for Packing Workers at PT X" Register: Medical Technology and Public Health Journal, Vol. 7, No. 2, pp. 154-165, 2023

ABSTRACT

Data derived from the Nordic Body Map (NBM) questionnaire results at PT X in March 2023 revealed that approximately 55.5% of packing workers reported experiencing extreme pain in their back and waist, attributed to manual handling tasks. This study aims to evaluate the safety of manual handling activities associated with cardboard packaging for finished products. Employing a quantitative analytic research approach with an observational method, the study includes a population and sample of 9 packing workers at PT X. Physical workload is assessed using the Cardiovascular Load method, and an ergonomic risk evaluation is conducted using the Composite Lifting Index (CLI) calculation method, considering the multitasking nature of packing work. Findings from the physical workload measurements highlight that one worker has a %CVL above 30%, placing the workload of all packing workers in the "needs improvement" classification. Additionally, CLI calculations for four units surpass the criteria, with values ≥ 3, signifying that all packing activities across units at PT X are deemed high-risk. Recommendations for improvement include adjusting the distance between the load and the body, refining lifting techniques, addressing work duration, adopting two-person lifting for heavy loads, and displaying posters with tips for manual weight lifting. Following the implementation of these proposed improvements, the results indicate that packing work at PT X is now considered safe to perform.

Keywords: *Composite lifting index, repair, workload*

INTRODUCTION

Technological advancements in the industrial sector are crucial in assessing a country's progress. These developments have significantly enhanced the standard and quality of human life, leading to increased production and work productivity (Anisa, 2017). The emergence of sophisticated and modern machines as tools for various industries has been a notable outcome of technological progress. However, in Indonesia, several industries still rely on human labor for material handling processes (Irawati & Carollina, 2017).

Manual material handling, commonly known as Manual Material Handling, if not executed ergonomically, can result in accidents. Occupational accidents often stem from damage to body tissues caused by lifting excessive loads (Purnomo, 2017). According to data released by the National Institute for Occupational Safety and Health (NIOSH) in 2017, nearly 500 thousand workers in the United States suffered various injuries related to excessive muscle use at work. Almost 60% of these injuries were associated with lifting tasks, and 20% involved pushing or pulling. Additionally, NIOSH data highlights that handling hazardous materials accounted for 53% of injuries, while manual material handling contributed to 43% of injuries in 2017 (Purnomo, 2017).

The accident data released by NIOSH solely records incidents and injuries occurring in developed countries. Meanwhile, incidents and injuries resulting from manual material handling in developing countries are substantial, though they remain unpublished with no accurate data collection. Accurate data collection on accidents and injuries related to manual material handling is crucial in Indonesia, especially considering its large population, to assess the adverse effects of manual lifting activities (Purnomo, 2017).

Manual Material Handling activities encompass lifting, pushing, shouldering, carrying, pulling, and other material lifting activities without mechanical aids (Purnomo, 2017). The flexibility of movements involved in manual material handling provides an advantage compared to mechanical aids. However, alongside these advantages, there are notable disadvantages, particularly concerning occupational safety and health. Manual material handling activities pose a significant potential for accidents, including "overexertion lifting and carrying" due to lifting excessive loads or damage to body tissues resulting from excessive lifting (Nurmianto, 2005) as cited in (Ratriwardhani, 2019).

Meanwhile, in occupational health, activities necessitate human physical energy as a source of power, wherein workability is entirely dependent on individuals acting as the driving force or controllers of work. The energy released or consumed results from metabolic processes occurring in the muscles, supported by the cardiovascular and respiratory systems within the body (Purba & Jabbar Rambe, 2014). When the level of physical load imposed on workers is excessively high, it leads to the overuse of energy, resulting in significant fatigue. Conversely, insufficient loading intensity can lead to boredom (Puteri & Sukarna, 2017).

In the Nordic Body Map (NBM) questionnaire conducted in December 2017 by Sheila Noor at the same location, with responses from 9 workers, 75% reported experiencing muscle pain in areas such as the knees, arms, and wrists. These complaints arose from the side effects of manual handling jobs. Consequently, in 2023, based on survey results and interviews conducted in January with PT X's Occupational Health and Safety and Environment (K3LH) staff, it was revealed that finished product packing activities still rely on human labor due to cost limitations.

The finished product packing process involves continuous manual work for 8 hours daily, with workers handling loads ranging from 15 to 21 kg. The manual process includes placing packages containing finished products into cartons, which pass through a designing machine. Subsequently, workers lift cardboard boxes weighing 19 kg to place them on a pallet. Once the pallet is fully loaded, it is transferred to the finished goods storage warehouse using a forklift.

Errors while lifting cartons containing finished products can result in losses, manifested as workers experiencing muscle pain, work-related fatigue, and decreased productivity. Aligned with these drawbacks, previous researchers have analyzed physical workload and non-ergonomic working postures. Ade Andhika Saputra et al. (2021) focused on measuring physical workload, using the cardiovascular method, RWL, and energy consumption to assess physical workload, determine work categories, and establish recommended lifting limits.

Another study by Wijaya et al. (2019), concentrating on determining employee workload through cardiovascular and RWL methods, revealed that while the Cardiovascular percentage %CVL value of the workforce fell within a moderate job classification, suggesting no need for improvement, the RWL calculation yielded a Lifting Index of 2.0-2.6. This indicates an LI value > 1, suggesting a continued risk of workforce injury due to loads exceeding limits.

In Ilmi & Dwiyanti's research (2021) on analyzing work posture using biomechanics and RWL methods, initial observations showed an average energy consumption value of 3.6 in the medium category. The average RWL value was 16.62, with an average lifting index of 1.63, posing a very high risk of causing spinal injuries. Consequently, improvements are necessary to establish safe limits for workers, prevent easy fatigue, and reduce the risk of injuries during load lifting.

Additionally, during the initial survey in March 2023 at the company, it was discovered that some workers reported pain in their skeletal muscles after lifting cardboard boxes onto pallets. This discomfort arises from excessive muscle contractions during prolonged and repetitive loading tasks. The workload imposed on workers should align with their capacity; an imbalance in workload can result in various adverse effects on both work outcomes and the physical well-being of the workforce.

Corroborating this, the results of the Nordic Body Map (NBM) questionnaire conducted in March 2023 indicate that all workers experienced muscle pain in specific areas. Notably, 55.5% of workers reported intense pain in the back and waist, while all workers experienced muscle pain in the knees, shoulders, arms, and wrists. The degree of pain varied across different body parts, ranging from non-painful to slightly painful, painful, and even very painful. Workers submitted these complaints regarding the side effects of manual handling work.

Hence, based on a company survey and insights from previous research, the researcher opted for the Recommended Weight Limit (RWL) method. This method provides a theoretical lifting load value recommended for lifting weights, while the Lifting Index (LI) expresses the relative estimated value of the level of physical stress during manual lifting activities (Noor et al., 2018). This method helps determine whether the load lifted or the posture aligned with the applicable standards. When standards are not met, recommendations for the work process are provided.

Additionally, the researcher employed indirect measurements of physical workload by assessing pulse rate. This approach objectively gauges the level of physical workload, estimates the degree of physical fitness of workers, and measures worker fatigue (Puteri & Sukarna, 2017). Implementing this method allows for the adjustment of work to match the workforce's capabilities in performing the tasks at hand.

MATERIAL AND METHODS

This research follows a quantitative approach, known for its systematic, planned, and structured nature, ensuring clarity from the beginning to the end of the research process, uninfluenced by existing field conditions. Within the narrow scope of quantitative research, it is defined as research heavily reliant on numerical data throughout data collection, analysis, and presentation. The quantitative approach underscores the analysis of numerical data, employing appropriate statistical methods for analysis (Sugiyono, 2017). The study adopts a cross-sectional study design involving direct observation of the lifting processes performed by packing workers at PT X. The research is set to take place in January-March 2023 at PT X in Kec. Manyar, Gresik

Regency, East Java. According to Sugiyono (2017), the research population is a generalized area encompassing objects/subjects with specific qualities and characteristics determined by researchers for study and conclusion drawing. This study's population consists of packing workers at PT X, totaling nine individuals.

According to Sugiyono (2017), the sample is part of the number and characteristics possessed by the population. According to other experts in this case, the definition of a sample (Arikunto, 2019) provides an understanding that the sample is part or representative of the population to be studied. The sample used in this study was packing workers, with nine workers at PT X.

Total sampling is employed when all population members are included as samples. This is typically done when the population is relatively small, consisting of fewer than 30 people. Another term for total sampling is a census, where every member of the population is sampled (Sugiyono, 2017). The methods utilized in this study include the %CVL and Recommended Weight Limit (RWL). The variables considered in this research encompass age, years of service, heart rate, and manual load shifting. Data collection techniques employed in the research include observation, interviews, and documentation. The type of data used in this study is primary data collected through direct observation of lifting activities performed by workers. These data are essential for completing all variables in the %CVL and NIOSH Lifting Equation. The primary data collection procedure is outlined as follows:

1. Cardiovascular Load
   a. Measure the speed of the heart rate using the 10 beats method
   b. Perform cardiovascular calculations, with the formula equation $\%\,CVL = \frac{(DNK-DNI)}{(DNM-DNI)} \times 100$
   c. Perform cardiovascular comparison with workload classification is as follows:
      30% = No fatigue occurs
      30% - 60% = Needs improvement
      60% - 80% = Work in a short time
      80% - 100% = Immediate action needed
      100% = Not allowed to move
2. Recommended Weight Limit (RWL)
   a. Calculating HM (Horizontal multiplier) using the formula from the NIOSH Lifting Equation $HM = 25 / H\ (H_{origin})$ dan $HM = 25 / H\ (H_{destination})$
   b. Calculating VM (Vertical Multiplier) using the Niosh Lifting Equation formula: *VM= (1-0,003 (V-75).*
   c. Calculating AM (Asymmetric Angle) using the NIOSH Lifting Equation formula: *AM* = (1 - (0.0032 A))
   d. Calculating DM (Distance Multiplier) using the NIOSH Lifting Equation formula: *DM= (0,82 + (4,5/D))*
   e. Calculating CM (Coupling Multiplier) is a classification of load forms and is assessed based on the categories listed in table 2.5 regarding coupling classifications.
   f. Calculating the recommended load to be lifted by a worker under certain conditions based on the NIOSH Lifting Equation using equation RWL = LC x HM x VM x DM x AM x FM x CM
   g. Then calculate the Lifting Index (LI) using equation $LI = \frac{Weight}{RWL}$

h. Calculating the Frequency Independent Recommended Weight Limit (FIRWL) with equation FIRWL = 23 x HM x VM x DM x AM x CM
i. Single Task Recommended Weight Limit (STRWL) with equation STRWL = FIRWL x FM
j. Calculating the Frequency Independent Lifting Index (FILI) with equation FILI = Weight/FIRWL
k. Calculating the Single Task Lifting Index (STLI) with equation STLI = Weight/STRWL
l. Assign a new job number. Starting with the highest STLI value then to the smallest.
m. Calculating Composite Lifting Index (CLI) with equation $\sum \Delta CLI = (FILI_2 \text{ x } \frac{1}{FM1,2} - \frac{1}{FM1})) + (FILI_3 \text{ x } \frac{1}{FM\ 1,2,3} - \frac{1}{FM1,2})) + (FILI_n \text{ x } \frac{1}{FM\ 1,2\ldots n} - \frac{1}{FM1,2\ldots n}))$

RESULTS AND DISCUSSION

Cardiovascular Load Percentage Calculation Results (%CVL)

The results obtained from calculating the percentage of %CVL, based on resting heart rate data, working heart rate, and maximum heart rate, can be classified as follows. The packing process for finished products entails continuous work for 8 hours each day, with workers handling heavy loads from various units. This includes data on the weights of the loads that workers in each unit must lift.

Table 1. Calculation Classification %CVL

Worker Name	Unit Name	%CVL	Classification
K	A	46,18	Needs improvement
A		75,00	Work in a short time
K	B	60,48	Work in a short time
M		62,50	Work in a short time
W	C	35,98	Needs improvement
F		39,82	Needs improvement
M	D	64,10	Work in a short time
M		125,19	Not allowed to move
S		38,14	No fatigue occurs

In the workload classification using the cardiovascular method, all packing workers in each unit have a %CVL above 30%. Consequently, the workload for all packing workers falls into the category requiring improvement, with restricted time for work and limitations on certain activities, as indicated in research by Puteri & Sukarna, 2017.

Referring to Table 1, the highest cardiovascular load among packing workers is observed in worker 8, with a %CVL calculation of 125.19%, placing them in the category of not being allowed to move. The %CVL value exceeds 100% due to the worker's older age compared to others and the greater volume of work they perform. Worker 8's working pulse significantly exceeds their resting pulse, increasing fatigue. The impact of age on work fatigue is evident, as age influences body resistance and work capacity. Older individuals experience a decline in their ability to perform heavy work, leading to quicker fatigue (Kusgiyanto, 2017).

Workers with the highest %CVL load exhibit shorter working times and engage in more work activities than their counterparts, resulting in diminished tolerance for the work. Tarwaka (2010) emphasized that the heavier the workload, the shorter the allowable working time without significant fatigue or distraction, and vice versa. Conversely, the worker with the smallest cardiovascular load is worker 5, with a %CVL value of 35.98%. Despite falling into the lowest %CVL category, significant fatigue is still observed, indicating a need for improvement. The smaller %CVL value in worker five is attributed to their younger age, signifying a higher fatigue tolerance for this type of work.

Composite Lifting Index Results for Packing Work

In the packing tasks that have been undertaken, an analysis of multitask lifting procedures was conducted to account for variations in lifting locations. This involved lifting loads weighing 19kg, 15kg, 21kg, and 20kg, each involving five stacks of pallets. The calculations presented a recapitulation of the origin and destination calculation data using the Recommended Weight Limit (RWL) method.

Table 2. Recap Results of Origin RWL and CLI Calculations

No.	Unit Name	Pile	RWL	Work Load	LI	FIRWL	FILI	STRWL	STLI	CLI
1.	A	1	9,09	19 Kg	2,09	13,99	1,36	9,09	2,09	8,03
		2	6,48		2,93	9,97	1,91	6,48	2,93	
		3	31,73		0,60	48,82	0,39	31,73	0,60	
		4	14,46		1,31	22,24	0,85	14,46	1,31	
		5	12,97		1,46	19,96	0,95	12,97	1,46	
2.	B	1	13,24	15 Kg	1,13	20,37	0,74	13,24	1,13	4,99
		2	6,62		2,27	10,19	1,47	6,62	2,27	
		3	30,26		0,50	46,56	0,32	30,26	0,50	
		4	21,01		0,71	32,33	0,46	21,01	0,71	
		5	19,35		0,78	29,77	0,50	19,35	0,78	
3.	C	1	7,75	21 Kg	2,71	11,92	1,76	7,75	2,71	12,66
		2	5,52		3,80	8,49	2,47	5,52	3,80	
		3	27,03		0,78	41,59	0,50	27,03	0,78	
		4	12,31		1,71	18,94	1,11	12,31	1,71	
		5	11,05		1,90	17,00	1,24	11,05	1,90	
4.	D	1	11,62	20 Kg	1,72	17,88	1,12	11,62	1,72	6,36
		2	8,28		2,42	12,74	1,57	8,28	2,42	
		3	40,55		0,49	62,38	0,32	40,55	0,49	
		4	18,47		1,08	28,42	0,70	18,47	1,08	
		5	16,58		1,21	25,50	0,78	16,58	1,21	

Table 3. Recap Results of Destination RWL and CLI Calculations

No.	Unit Name	Pile	RWL	Work Load	LI	FIRWL	FILI	STRWL	STLI	CLI
1.	Herbisida I	1	7,90	19 Kg	2,41	12,15	1,56	7,90	2,41	8,70
		2	5,97		3,18	9,18	2,07	5,97	3,18	
		3	30,88		0,62	47,50	0,40	30,88	0,62	
		4	14,82		1,28	22,80	0,83	14,82	1,28	
		5	13,98		1,36	21,51	0,88	13,98	1,36	
2.	Herbisida II	1	9,14	15 Kg	1,64	14,07	1,07	9,14	1,64	7,20
		2	4,85		3,10	7,46	2,01	4,85	3,10	
		3	23,41		0,64	36,01	0,42	23,41	0,64	

No.	Unit Name	Pile	RWL	Work Load	LI	FIRWL	FILI	STRWL	STLI	CLI
		4	17,12		0,88	26,34	0,57	17,12	0,88	
		5	16,57		0,91	25,50	0,59	16,57	0,91	
3.	Padatan	1	8,39	21 Kg	2,50	12,91	1,63	8,39	2,50	9,26
		2	6,34		3,31	9,76	2,15	6,34	3,31	
		3	32,81		0,64	50,47	0,42	32,81	0,64	
		4	15,75		1,33	24,23	0,87	15,75	1,33	
		5	14,85		1,41	22,85	0,92	14,85	1,41	
4.	Sidafur	1	8,39	20 Kg	2,38	12,91	1,55	8,39	2,38	8,28
		2	6,34		3,15	9,76	2,05	6,34	3,15	
		3	32,81		0,61	50,47	0,40	32,81	0,61	
		4	15,75		1,27	24,23	0,83	15,75	1,27	
		5	14,85		1,35	22,85	0,88	14,85	1,35	

For tasks falling under multitask lifting, the Lifting Index (LI) calculation transforms into the Composite Lifting Index (CLI), representing the combined risk index for the five lifts. The CLI calculation results for each unit are as follows: Unit A 8.63 at the origin and 8.70 at the destination, Unit B 4.99 at the origin and 7.20 at the destination, Unit C 12.66 at the origin and 9.26 at the destination, and Unit D 6.36 at the origin and 8.28 at the destination. The calculated CLI values surpass the set criteria of ≥ 3, while the permissible value is < 3. This categorizes all packing activities in each unit at PT X as high-risk CLI.

In accordance with NIOSH guidelines, lifting tasks with LI > 1 pose an increased risk of lower back pain for some workers. Manual material handling activities bear a significant potential for accidents, specifically those caused by lifting excessive loads, referred to as "overexertion lifting and carrying" or damage to body tissue due to excessive lifting (Nurmianto, 2005) as cited in (Ratriwardhani, 2019). NIOSH recommends that all lifting tasks be designed to achieve an LI of 1 or less. Experts concur that when the LI value exceeds 1, and CLI surpasses 3, most jobs will experience an elevated risk. Thoroughly checking and promptly improving all parameters causing high values is essential.

Possible Recommendations for Manual Handling Activities

This proposed method can be applied and allows for packing workers because researchers have made observations of the manual handling work area. The following is a proposed method that can be applied:

1. Improvement of Load Distance with Body

   Improved Load Distance to the Body (Horizontal multiplier) by bringing the body closer to the load, this control will also not interfere with productivity and is unrelated to other factors. By making the distance between the load and the body H <25 cm, intervention is still needed on other factors so that the risk index for lifting becomes less than 1.
2. Improved Lifting Angle Between Workers and Load Positions

   Improvement of the Lifting Angle Between the Worker and the Load Position (Asymmetric Multiplier) that can be done to avoid angles when lifting is that workers must move objects correctly, namely not only moving the spine but the whole body in lifting. Thus, workers are expected to do manual lifting as much as possible with A = 0
3. Improved Work Duration

In this case, the work duration can be reduced by 2 – 1 hour. By improving work duration reduction, the lifting frequency multiplier factor also has an effect. The multiplier factor generated after reducing the work duration is 0.65 to 0.84.

4. Lifting Weights with Two People

Team handling is carried out to reduce the burden on workers, namely by lifting the burden together so that the load lifted can be reduced because the weight of the load will be divided. Modifying these ergonomics can decrease the values of the Individual Lifting Index (STLI) and the Combined Lifting Index (CLI).

5. Manual Weight Lifting Tips Poster

Based on observations made by researchers, one of the best solutions that can be done in the near future to overcome the problem of manual lifting activities for packing workers is to train workers by conducting socialization and correct posture training when moving and lifting loads. This is intended to improve posture when workers carry out the position of lifting cartons so that further activities can be carried out properly and correctly.

The next step is to explain the correct lifting and the required position to workers by using an infographic poster that explains good and correct lifting posture. With the infographic posters, it is hoped that workers will get examples of practices in accordance with the guidelines and workers will implement these practices. The following is a poster recommended by researchers for outreach to packing workers at PT. X.

Simulation Of Calculation Results After Improvement

After getting the result that the CLI value exceeds ≥ 3. This shows that all packing activities in each unit at PT X are in the high-risk CLI category. Therefore, a calculation simulation is carried out if all recommendations are implemented. Calculations were performed using the NIOSH Lifting Equation.

Table 3. Recap Results of Origin RWL and CLI Simulation of Calculation Results After Improvement

No.	Unit Name	Pile	Work Load	RWL	LI	FIRWL	FILI	STRWL	STLI	CLI
1.	A	1	19 Kg	13,51	1,41	16,09	1,18	13,51	1,41	2,83
		2		9,63	1,97	11,47	1,66	9,63	1,97	
		3		47,16	0,40	56,14	0,34	47,16	0,40	
		4		21,48	0,88	25,57	0,74	21,48	0,88	
		5		19,28	0,99	22,95	0,83	19,28	0,99	
2.	B	1	15 Kg	17,11	0,88	20,37	0,74	17,11	0,88	2,35
		2		8,56	1,75	10,19	1,47	8,56	1,75	
		3		39,11	0,38	46,56	0,32	39,11	0,38	
		4		27,15	0,55	32,33	0,46	27,15	0,55	
		5		25,01	0,60	29,77	0,50	25,01	0,60	
3.	C	1	21 Kg	18,02	1,17	21,45	0,98	18,02	1,17	2,32
		2		12,84	1,64	15,29	1,37	12,84	1,64	
		3		62,88	0,33	74,86	0,28	62,88	0,33	
		4		28,64	0,73	34,10	0,62	28,64	0,73	
		5		25,71	0,82	30,61	0,69	25,71	0,82	
4.	D	1	20 Kg	15,02	1,33	17,88	1,12	15,02	1,33	2,82
		2		10,70	1,87	12,74	1,57	10,70	1,87	
		3		52,40	0,38	62,38	0,32	52,40	0,38	
		4		23,87	0,84	28,42	0,70	23,87	0,84	
		5		21,42	0,93	25,50	0,78	21,42	0,93	

Table 4. Recap Results of Destinations CLI Simulation of Calculation Results After Improvement

No.	Unit Name	Pile	Work Load	RWL	LI	FIRWL	FILI	STRWL	STLI	CLI
1.	A	1	19 Kg	13,58	1,40	16,17	1,17	13,58	1,40	2,65
		2		10,26	1,85	12,22	1,56	10,26	1,85	
		3		53,09	0,36	63,21	0,30	53,09	0,36	
		4		25,48	0,75	30,34	0,63	25,48	0,75	
		5		24,04	0,79	28,62	0,66	24,04	0,79	
2.	B	1	15 Kg	13,80	1,09	16,43	0,91	13,80	1,09	2,61
		2		7,32	2,05	8,71	1,72	7,32	2,05	
		3		35,34	0,42	42,07	0,36	35,34	0,42	
		4		25,85	0,58	30,78	0,49	25,85	0,58	
		5		25,02	0,60	29,79	0,50	25,02	0,60	
3.	C	1	21 Kg	15,23	1,38	18,14	1,16	15,23	1,38	2,76
		2		11,51	1,82	13,70	1,53	11,51	1,82	
		3		59,55	0,35	70,89	0,30	59,55	0,35	
		4		28,58	0,73	34,02	0,62	28,58	0,73	

No.	Unit Name	Pile	Work Load	RWL	LI	FIRWL	FILI	STRWL	STLI	CLI
		5		26,96	0,78	32,09	0,65	26,96	0,78	
4.	D	1	20 Kg	15,23	1,31	18,14	1,10	15,23	1,31	2,58
		2		11,51	1,74	13,70	1,46	11,51	1,74	
		3		59,55	0,34	70,89	0,28	59,55	0,34	
		4		28,58	0,70	34,02	0,59	28,58	0,70	
		5		26,96	0,74	32,09	0,62	26,96	0,74	

The CLI calculation results obtained from each unit are Unit A 2.83 at origin and 2.65 at destination. Unit B: 2.35 at origin and 2.61 at destination. Unit C 2.32 at origin and 2.76 at destination. Unit D 2.82 at origin and 2.58 at destination. It can be seen that based on the calculation, the CLI value does not exceed the criteria, namely < 3. This shows that PT X is safe to work on after the proposed method of packing work. The combined lifting index or Composite Lifting Index (CLI) produces CLI <3, so it is necessary to improve in carrying out these activities, both from work attitudes and the work environment, but this does not need to be done as soon as possible.

CONCLUSION AND SUGGESTION

In this study, employees' physical workload was measured using the Cardiovascular Load method, and Ergonomic risk assessment analysis was carried out using the Composite Lifting Index (CLI) calculation method because packing work is a multitask. The results of physical workload measurements show that one worker has the largest %CVL, namely 125%, and one worker has the smallest %CVL, which is 35.98%. From the results of measuring the physical workload, all packing workers experience fatigue due to the workload received because %CVL> 30%.

From the results of the Composite Lifting Index (CLI) calculation, the CLI results for each unit were obtained, namely, Unit A was 8.63 at the origin and 8.70 at the destination. Unit B 4.99 at origin and 7.20 at destination. Unit C 12.66 at origin and 9.26 at destination. Unit D 6.36 at origin and 8.28 at destination. Based on the calculation, it was found that the CLI value exceeded the criteria, namely ≥ 3.

This shows that all packing activities in each unit at PT X are classified as high-risk. So, it can provide recommendations for layering the distance between the load and the body, improving the lifting angle, lifting the load with two people, and posters regarding manual lifting tips. It can be seen that based on the calculation, the CLI value does not exceed the criteria, namely < 3. This shows that it is safe to work on after the PT X packing work proposed method is carried out. The Composite Lifting Index (CLI) yields a CLI <3.

ACKNOWLEDGEMENT

The author would like to thank the packing workers at PT X as research respondents and the student team who helped the research process until this research was published. Thank you to the Occupational Safety and Health Study Program, Faculty of Health, Nahdlatul Ulama University, Surabaya.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this research.

REFERENCES

Ade Andhika Saputra, Wahyudin, & Asep Erik Nugraha. (2021). Evaluasi Aktivitas Manual Material Handling Dengan Menggunakan Metode Biomekanika Kerja Pada Pengangkatan Thiner di Bagian Warehouse. *Jurnal Sistem Teknik Industri*, *23*(2), 233–244. https://doi.org/10.32734/jsti.v23i2.6273

Anisa, A. (2017). *Faktor-Faktor yang Dapat Berhubungan dengan Potensi Kecelakaan Kerja pada Pandu dalam Pemanduan Kapal Niaga di PT. Pelabuhan Indonesia I (Persero) Belawan Tahun 2017* [Universitas Sumatera Utara]. http://repositori.usu.ac.id/handle/123456789/1755

Budiman, A., Husaini, & Arifin, S. (2016). Hubungan antara umur dan indeks beban kerja dengan kelelahan pada pekerja di pt. karias tabing kencana 1. *Jurnal Berkala Kesehatan*, *1*(2), 121–129.

Diniaty, D., & Muliyadi, Z. (2016). *Analisis Beban Kerja Fisik Dan Mental Karyawan Pada Lantai Produksi Dipt Pesona Laut Kuning*. *13*(2), 203–210.

Faiz, N. (2014). *Faiz, Nurli."Faktor - Faktor yang Berhubungan dengan KelelahanKerja pada Pekerja Bagian Operator SPBU di KecamatanCiputat Tahun 2014". [Skripsi] Jakarta:Universitas Islam Negeri Syarif Hidayatullah, 2014.* Universitas Islam Negeri Syarif Hidayatullah Jakarta.

Ilmi, N., & Dwiyanti, D. O. (2021). Analisis Beban dan Produktivitas Kerja Pemindahan Manual serta Semi-Manual Air Galon. *Jurnal Ilmiah Teknik Industri*, *6*(1), 17–23.

Irawati, R., & Carollina, D. A. (2017). Faktor yang mempengaruhi beban kerja. *Inovbiz: Jurnal Inovasi Bisnis*, *5*(1), 51. https://media.neliti.com/media/publications/236276-analisis-pengaruh-beban-kerja-terhadap-k-9514b0dc.pdf

Kusgiyanto, W., Suroto, & Ekawati. (2017). Analisis Hubungan Beban Kerja Fisik, Masa Kerja, Usia, Dan Jenis Kelamin Terhadap Tingkat Kelelahan Kerja Pada Pekerja Bagian Pembuatan Kulit Lumpia Di Kelurahan Kranggan Kecamatan Semarang Tengah. *Jurnal Kesehatan Masyarakat*, *5*, 413–423. https://ejournal3.undip.ac.id/index.php/jkm

Lestari, I. (2020). Pengukuran Beban Kerja Fisik Pada Karyawan Pemindahan Produk Pt. Tirta Sukses Perkasa Gowa. Kementerian Perindutrian R.I Politeknik Ati Makassar.

Maulidi, M. N. (2010). *Faktor-faktor Yang Berhubungan Dengan Kelelahan PadaPekerja di Proses Produksi Kantong Semen PBD (Paper Bag Division) PT.Iindocement Tunggal Prakarsa TBK Citeureup Bogor*. Universitas Islam Negeri Syarif Hidayatullah.

Ninggar, G. D. (2018). Pengukuran Cardiovascular Load Dalam Penentuan Keseimbangan Beban Kerja Fisik *(Studi Kasus Di PT . Yamaha Indonesia)*. Universitas Islam Indonesia.

Noor, S., Handoko, L., A, H. N., Studi, P., Keselamatan, T., Kesehatan, D. A. N., Teknik, J., Kapal, P., Perkapalan, P., & Surabaya, N. (2018). Analisis Penilaian Risiko Ergonomi Pada Pekerjaan Manual Handling Di Unit Produksi Wp Plan. Politeknik Perkapalan Negeri Surabaya.

Notoadmojo, S. (2018). *Metodologi Penelitian Kesehatan* (1st ed.). Rineka Cipta.

Prastawa, H., Rosyada, Z. F., Hidayah, M. F., & Nurlaili, P. (2021). *Fisiologis Untuk Meningkatkan Produktivitas*. *16*(1), 10–20.

Purba, E., & Jabbar Rambe, A. M. (2014). Analisis Beban Kerja Fisiologis Operator Di Stasiun Penggorengan Pada Industri Kerupuk. *Jurnal Teknik Industri FT USU*, *5*(2), 11–16.

Purbasari, A., & Purnomo, A. J. (2019). Penilaian Beban Fisik Pada Proses Assembly Manual Menggunakan Metode Fisiologis. *Sigma Teknika*, *2*(1), 123. https://doi.org/10.33373/sigma.v2i1.1957

Purnomo, H. (2017). *Manual Materials Handling* (1st ed.). Universitas Islam Indonesia. https://doi.org/10.1002/9781119276531.ch3

Puteri, R. A. M., & Sukarna, Z. N. K. (2017). Analisis Beban Kerja Dengan Menggunakan Metode Cvl Dan Nasa-Tlx Di Pt. Abc. *Spektrum Industri*, *15*(2), 211. https://doi.org/10.12928/si.v15i2.7554

Ratriwardhani, R. A. (2019). Analisa Aktivitas Pengangkatan Dengan Metode Recommended Weight Limit (Rwl). *Medical Technology and Public Health Journal*, *3*(1), 94–100. https://doi.org/10.33086/mtphj.v3i1.947

Safe Work Australia. (2022). Code of Practice Hazardous Manual Tasks. In *Australian Government* (Issue Juli). Goverment of Western Australia Departemen of Mines, Industry Regulation and Safety. http://creativecommons.org/licenses/by-nc/3.0/au/%0Ahttp://www.disabilitysafe.org.au/hazards-risks/manual-handling

Sanjaya, K. T., Wirawan, N. H., & Adenan, B. (2018). Analisis Postur Kerja Manual Material Handling Menggunakan Biomekanika dan Niosh. *JATI UNIK : Jurnal Ilmiah Teknik Dan Manajemen Industri*, *1*(1), 61. https://doi.org/10.30737/jatiunik.v1i2.114

Sitohang, D. R., Winaningthias, M., & Iridiastadi, H. (2012). Evaluasi Beban Fisiologis Pada Industri Manufaktur (Industri Pembuatan Komponen Pesawat Terbang Dan Industri Sepatu). *J@ti Undip: Jurnal Teknik Industri*, *5*(2), 119–126. http://ejournal.undip.ac.id/index.php/jgti

Sugiyono. (2017). *Metode Penelitian Kuantitatif Kualitatif dan R & D* (1st ed.). CV Alfabeta.

Waters TR, P. ., Putz–Anderson V, P. D., Garg A, P. D., & Cincinnati. (2021). NIOSH [1994]. Applications manual for the revised NIOSH lifting equation. In *OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH)*. https://doi.org/10.26616/NIOSHPUB94110revised092021.

Wijaya, R., Kusmindari, C. D., & Renilaili. (2019). Penentuan Beban Kerja Karyawan Menggunakan Metode Cardiovascular Load dan Recommended Weight Limit (Studi Kasus PT. Sunan Rubber). *Jurnal Teknik Industri Univesitas Binadarma Palembang*, 364–373.

Yuliani, E. N. S., Tirtayasa, K., Adiatmika, I. P. G., Iridianto, H., & Adiputra, N. (2021). Studi Literatur : Pengukuran Beban Kerja. *Jurnal Penelitian Dan Aplikasi Sistem & Teknik Industri (PASTI)*, *XV*(2), 194–205.