Analysis of Employee Work Posture and Physical Workload Using del Riesgo Individual Evalution and Cardio-Vascular Load Methods

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Abstract. The role of humans as workers is still dominant in carrying out the production process, especially activities carried out manually in Material Handling (MMH). Activities carried out using the MMH method are identified as having a high risk if they are not carried out ergonomically and with a good work system, musculoskeletal complaints can occur due to wrong work postures and physical workload. The production process for SME Barokah Tofu in Kendal Regency is still carried out manually by employees who have identified incorrect work postures due to musculoskeletal complaints and physical workload. Therefore, it is necessary to analyze work posture and physical workload of Barokah Tofu employees who have a high risk to reduce musculoskeletal complaints and high physical workload, as well as provide suggestions for improvements to Barokah Tofu. The methods used in this research are ERIN (Evaluation Del Riesgo Individual) and CVL (Cardiovascular Load). Based on the calculation results, it can be concluded that there are 2 activities that have the results of the classification of work posture and physical workload inversely, namely soybean milling and moulding of tofu where work posture has a high risk and physical workload has a low risk, and there are 2 activities that have a work posture classification result. and the physical workload is directly proportional, namely filtering cooking products with low risk and cutting tofu with high risk. Activities that have a high risk require suggestions for improvements, namely simulation of tool design and Standard Operating Procedures (SOP) for the application of ergonomic principles at work.

1 Introduction

The role of humans as workers is still dominant in carrying out the production process, especially activities that are carried out manually. These activities include the body's coordination systems such as the hands, muscles, and spine [1]. Activities carried out

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manually are often referred to as manual material handling (MMH). One of the manual jobs will have a high risk if it is not done ergonomically. One of them will be "over exertion", namely damage to the body's muscles caused by excessive lifting weights [2].

One thing that can influence workers while working is body ergonomics, such as posture and posture when carrying out work [3]. Wrong work posture can cause fatigue and discomfort in doing work. Incorrect working posture over a long period of time can cause injury and complaints to skeletal muscle tissue and peripheral nerves [4]. Muscle tissue and peripheral nerves are part of the musculoskeletal system [5], which is a skeletal system composed of bones consisting of 206 bones that make up the skeleton [6]. Musculoskeletal complaints are complaints from the skeletal muscles that a person experiences ranging from very mild complaints to very painful. If muscles receive static loads repeatedly and for a long period of time, it will cause complaints such as damage to joints, ligaments and tendons [7]. Every worker has a workload in carrying out their work. One of them is the physical workload. Physical workload is related to the heart's work system in providing oxygen for muscle work and removing metabolic waste. Physical workload is caused by excessive physical activity using the body's muscle strength. Excessive physical workload causes fatigue in workers [8].

The entire production process carried out at SME Barokah Tofu is still done manually. In the tofu production process, there were identified problems related to wrong work postures in each work element. The result is that workers experience musculoskeletal problems [9]. In each element of Barokah Tofu work, it was found that the wrong work posture was found for the employees. This posture error occurs when working the back is too bent, the neck is too bent, and the flexion of the shoulders and arms is wrong. One of the injuries experienced by employees in the work elements of grinding soybeans, making tofu, and cutting tofu is pain, stiffness, numbness in the nerves and muscles, especially in the back and wrists. This is caused by repetitive manual activities and non-ergonomic work stations. Apart from body posture problems, physical workload problems were also identified for several workers at Barokah Tofu. The physical workload is caused by work that is carried out repeatedly and continuously. Workers have to do double work on tofu cutting work elements, there are few rest breaks, and work stations are not ergonomic.

Based on the description above, it is necessary to study work postures that have a high level of risk to reduce musculoskeletal complaints and prevent musculoskeletal disorders from occurring in workers. Evaluation was carried out using the Evaluation Del Riesgo Individual (ERIN) method. The evaluation of high-risk physical workload uses the Cardiovascular Load (CVL) method. This article will also provide suggestions for improvements to the conditions above.

2 Methods

Barokah Tofu has 16 employees who are in the production process section. The sample used in this study was 1 employee who worked on each work element in the tofu production process. This sample determination follows a purposive sampling technique, where this technique can be used on homogeneous samples, which focus on one particular subgroup where all sample members are similar in terms of occupation [10]. The homogeneity in question is the work posture that is used the same when carrying out activities for each work element. The same musculoskeletal complaints are also felt by employees at the same work element. For physical workload research, 1 sample of employees for each work element is also used, because of the homogeneity of work activities and workers. Each work element has the same activity, age, and the same average duration of working hours. Before taking the pulse, a health check-up is carried out first to ensure that all employees are in good health so that when measuring the pulse, all employees are in the same condition [11].

We conducted interviews with employees to find out their musculoskeletal complaints. Work posture data was obtained through direct observation with the help of documentation in the form of photos and videos. Photo and video documentation is used to determine the flexion of each employee's body parts and to analyze the movement time of each member of his body.

The working pulse rate is measured directly when the employee is carrying out activities that have lasted for 1 hour, to obtain cardiovascular load. Heart rate measurements are also carried out when employees are resting, using the 10 beat method using a stopwatch.

Data processing was carried out using the Evaluación del Riesgo Individual (ERIN) and cardio-vascular load (CVL) methods. The ERIN method is an evaluation of individual risk assessment based on available ergonomic tools. The ERIN method focuses on the interaction of several physical factors in the workplace but also includes worker assessment [12].

Cardiovascular Load (CVL) is a physical workload analysis method that compares the maximum pulse rate with the working pulse rate [13]. Calculation of pulse rate to calculate working pulse rate and resting pulse rate using a stopwatch using the 10 beat method.

Conducting physical workload measurement through heart rate variable. Pulse measurement is carried out while doing work. Work rate calculation used to assess the weight (heavy or light) of a workload. By using this method, pulse rate can be calculated as [14]:

$$\%CVL = \frac{100 \text{ x (working pulse} - \text{resting pulse)}}{\text{max pulse} - \text{resting pulse}} \quad (1)$$

The %CVL calculation will be compared with the classification that has been determined in Table 1.

Table 1. CVL classification

% CVL	CVL classification
<30%	No fatigue
30 s.d 60%	Required repair
60 s.d <80%	Work in no time
80 s.d <100%	Urgent action is required
>100%	No activities allowed

3 Results and Discussion

3.1 Figure and Table

Work posture data were obtained by making direct observations in the field at 10.00 – 13.00 WIB. Observe the frequency of movement and attitude of the body parts to be measured and calculated using the ERIN scoring table. The body parts observed are the torso, shoulders or arms, hands or wrists, and neck. The results of flexion measurements of several body parts used to calculate the ERIN scoring table. The recapitulation results of body flexion measurements for each activity are in Table 2.

Each activity has different body posture stressors. In the activities of milling soybeans, molding tofu, and cutting tofu, the greatest stress is on the torso [15]. Meanwhile, the filtering activity resulting from cooking with the greatest stress is the shoulders or arms.

Working pulse rate is obtained by measuring the pulse rate after the worker has worked for 2 hours to obtain cardiovascular load, namely at 10.00 WIB. The resting pulse rate was

obtained during the break after lunch, namely at 12.30 WIB. The pulse is taken by an expert doctor so that the data is accurate. Physical workload data is in Table 3.

Table 2. Recapitulation of body flexion measurements

Activity	Torso flexion	Shoulder or Arm Flexion	Hand or Wrist Flexion	Neck Flexion
Soybean milling	108,26°	90,49°	34,12°	58,04°
Dregs filtering	-	45,72°	35,92°	20,51°
Tofu moulding	68,60°	48,92°	59,57°	42,45°
Tofu cutting	63,13°	38,52°	38,70°	58,85°

Table 3. Data of physical workload

Name	Age	Work element	Work hour	Working pulse	Resting pulse
Juwarman	37 yrs	Soybean milling	8 hrs	107,52	93,03
Ihsan	39 yrs	Dregs filtering	8 hrs	106,38	78,84
Saiful	30 yrs	Tofu moulding	8 hrs	117,92	99,04
Sriyati	34 yrs	Tofu cutting	8 hrs	112,69	78,67

3.2 Analysis of Work Posture Using ERIN

The results of measuring work posture angles and worker assessments using the ERIN sheet are scored by marking numbers in the columns and rows on the ERIN sheet. From the ERIN scoring results, the total score is obtained from adding up the scores of the seven variables that have been determined. This value used to determine the risk level whether it has low, medium, high, and very high risk as well as recommended actions for improvement as shown in Table 4.

Table 4. Determination of ERIN Risk Level [16]

Color	Score	Risk Level	Recommended action
	17 - 14	Low	There is no need to make changes
	15 -23	Medium	In-depth research is needed, changes may be made
	24 - 35	Hard	Changes are made over a short period of time
	> 36	Very Hard	Urgent change is needed

Based on the ERIN scoring results for the soybean milling process activity, a score of 38 was obtained, which means the results are included in the very hard category so immediate changes are needed. After carrying out overall calculations for each work element using the ERIN method, a recapitulation of the calculation results of all tofu production process activities is obtained in Table 5.

Tabel 5. Recapitulation of ERIN Scoring Result

Activity	Scoring							Total	Level
	Body	Arms/ Shoulders	Hands/ Wrists	Neck	Work Activities	Effort Intensity	Employee Assessment		
Soybean milling	6	7	4	6	7	7	1	38	Very Hard
Dregs filtering	3	5	4	2	5	2	2	23	Medium
Tofu moulding	6	5	5	6	5	2	1	30	Hard
Tofu cutting	7	2	5	6	5	2	1	28	Hard

Based on Table 5, it is known that there are 2 activities that are classified as high with the male operator scoring in the very hard category (namely the soybean milling activity) and the hard category (namely the tofu molding activity). Apart from that, there was 1 activity that resulted in a high classification with the female operator scoring in the hard category (namely the tofu cutting activity). And there was also 1 activity that resulted in a low classification with the male operator getting a score that was included in the medium category (namely the activity of filtering cooking results).

3.3 Analysis of Physical Workload Using the CVL Method

The data used to calculate this method is the length of time to measure 10 pulse rates. The results of calculating work pulse and resting pulse for a sample of each employee activity carried out at Barokah Tofu, are as in Table 6.

Based on the results of processing samples of physical workload data for each activity, CVL classification results were obtained according to the predetermined classifications in Table 6.

Table 6. Recapitulation of CVL Calculation and Classification Results

Name	Activity	Working pulse	Resting pulse	%CVL calculation result	CVL classification
Juwarman	Soybean milling	107,52	93,03	16,105%	No fatigue occurs
Ihsan	Dregs filtering	106,38	78,84	26,957%	No fatigue occurs
Saiful	Tofu moulding	117,92	99,04	20,756%	No fatigue occurs
Sriyati	Tofu cutting	112,69	78,67	38,955%	Repair required

From the CVL classification results, there is a high physical workload in tofu cutting activities with female operators. Meanwhile, the activities of milling soybeans, filtering cooking products, and molding tofu with male operators have a low physical workload. This can be caused by gender factors, the body size and muscle strength of men are greater than women. In addition, female operators do double work in cutting, packaging and packing tofu activities.

The final result of processing research data on work posture and physical workload is in the form of a classification that contains provisions for each ERIN and CVL method. Based on the results of data processing on work posture and physical workload, there are activities that obtain different classification results from the two studies. The classification results from data processing research on work posture and physical workload show activities that are directly proportional and contradictory. The classification results can be seen in Table 7.

Tabel 7. Classification Results of Working Posture and Physical Workload Data Processing

Activity	Result of ERIN scoring calculation	ERIN Risk Level Classification	Result of CVL calculation	CVL classification
Soybean milling	38	Very Hard	15,105%	No fatigue occurs
Dregs filtering	31	Hard	38,955%	No fatigue occurs
Tofu moulding	30	Hard	20,756%	No fatigue occurs
Tofu cutting	23	Medium	26,957%	Repair required

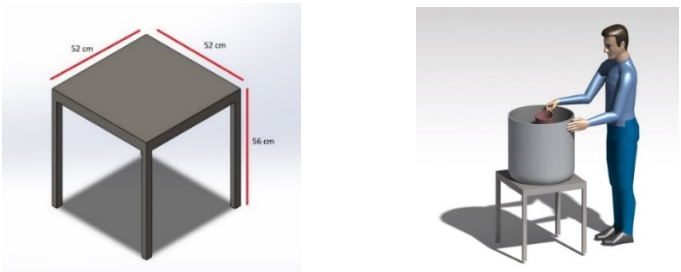
Based on the classification results table, there are differences in classification between working posture data processing and physical workload. There are 2 activities from the classification results that are in contrast to male operators, namely soybean milling and tofu molding activities. Factors that may be the cause of the difference in classification are age because the worker's age is still relatively productive where the body's organs are still stable so they don't get tired easily, gender because the body size and muscle strength of men are greater than women, the working period of male operators is 20 years because they tend to experience lower work fatigue while female operators have worked for 2 years, and psychologically because workers do not feel stressed [17].

Furthermore, there are 2 activities with directly proportional classification results, namely the activity of filtering cooking results with a male operator resulting in a low classification and the activity of cutting tofu with a female operator resulting in a high classification. From this explanation, it was concluded that the activities that needed to be proposed for improvement were the soybean milling and tofu molding activities with male operators because the results of the work posture classification showed a high level of risk as well as the tofu cutting activities with female operators because the results of the work posture classification and physical workload were the same. -sama produces a high classification.

3.4 Proposed Improvements

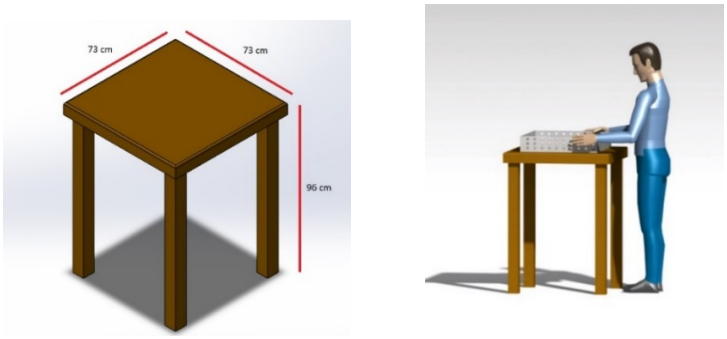
Based on the results of the data processing analysis, it is necessary to propose improvements to reduce the level of musculoskeletal risk which can cause injury and reduce high physical workloads. The proposed improvement is in the form of tool design based on anthropometric science. This is expected to create an ergonomic work station.

Figure 1, Figure 2 and Figure 3 show additional work equipments and correction of workers' posture errors in soybean milling, tofu molding and tofu cutting activities. These additional work equipments are used to adjust the work being done to reduce extreme flexion in the work posture and workers who have a tall posture do not bend too much.



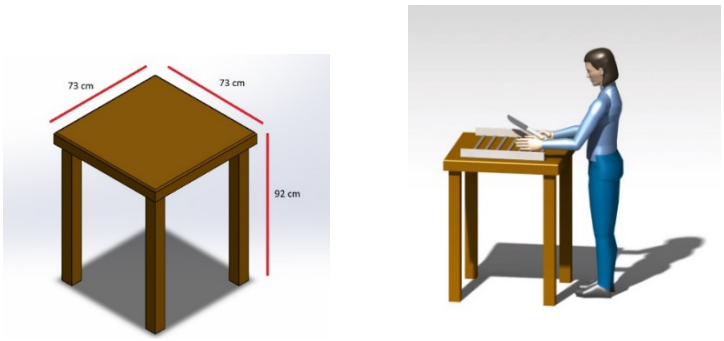
(a) (b)

Figure 1. Bucket coasters and posture improvements in soybean milling activities



(a) (b)

Figure 2. Work table and improving posture in tofu moulding activities



(a) (b)

Figure 3. Work table and improving posture in tofu cutting activities

4 Conclusion

From the results of processing work posture data using the ERIN method and physical workload using the CVL method, it can be concluded that the classification results of the two methods are directly proportional and inversely proportional. Activities that have a directly proportional classification, namely filtering cooking results with a low classification, are included in the medium category for work posture and do not need improvement for physical workload. Furthermore, the tofu cutting activity with a high classification is hard for work posture and needs to be improved for the physical workload. Activities that have an inversely proportional classification are soybean milling with a very hard classification for work posture and no need for improvement for physical workload. Furthermore, the moulding activity is classified as hard for work posture and does not need improvement for physical workload.

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