Improvement in Body Posture of Sumedang Tofu Small Enterprise Workers Using Workplace Ergonomic Risk Assessment (WERA)

Perbaikan Postur Tubuh Pekerja Usaha Kecil Tahu Sumedang Menggunakan Workplace Ergonomic Risk Assessment (WERA)

Merry Siska*, Aisyah Aulia Harahap
Department of Industrial Engineering, Faculty of Science and Technology,
Universitas Islam Negeri Sultan Syarif Kasim Riau
Jl. HR. Soebrantas KM. 15, Pekanbaru 28293, Indonesia
*merry.siska@uin-suska.ac.id

Abstract

This study aims to analyse the work body postures, to determine the work risk level before and after the improvement using the Workplace Ergonomic Risk Assessment (WERA) and to improve the workstation by designing ergonomic production tools. An empirical study was carried out at a small industry producing Sumedang Tofu at Rimbo Panjang, Pekanbaru, Indonesia. The workers must bend their body to move 77 kg soybeans with an 11 kg single-lifting capacity. The level of work risk was determined using the Workplace Ergonomic Risk Assessment (WERA) method based on nine categories, i.e., shoulders, wrists, back, legs, neck, strength, vibration, contact pressure, and work duration. The soaking and milling stations scored 35 and 31 using the WERA method. The two scores indicated an average performance level that requires improvement. Anthropometric data were used to develop tools for improving workers' body posture. The new tool used for soaking and milling has footrests, so workers did not have to reach too far above their chests to move the soybeans to the milling. The soaking station and the milling station both achieved a score of 24, which is considered as a low level, indicating that neither station requires improvement. Time reduction after the body posture improvement was 3.33 seconds for the milling station and 2.08 seconds for the soaking station.

Keywords: anthropometry, soybean, posture improvement, Workplace Ergonomic Risk Assessment

Abstrak

Penelitian ini bertujuan untuk mengidentifikasi postur kerja untuk mengetahui tingkat risiko kerja sebelum dan sesudah dilakukan perbaikan menggunakan metode Workplace Ergonomic Risk Assessment (WERA) dan memperbaiki workstation dengan merancang alat produksi yang ergonomis. Sebuah studi empiris dilakukan di sebuah usaha kecil tahu Sumedang di Rimbo Panjang, Pekanbaru, Indonesia. Para pekerja perusahaan harus membungkuk untuk memindahkan 77 kg kedelai dengan kapasitas angkat 11 kg. Tingkat risiko kerja ditentukan dengan menggunakan metode Workplace Ergonomic Risk Assessment (WERA) berdasarkan sembilan kategori, yaitu bahu, pergelangan tangan, punggung, kaki, leher, kekuatan, getaran, tekanan kontak, dan durasi kerja. Stasiun perendaman dan stasiun penggilingan memperoleh skor 35 dan 31 dengan menggunakan metode WERA sebelum perbaikan postur tubuh. Kedua skor tersebut menunjukkan tingkat kinerja rata-rata yang memerlukan perbaikan. Data antropometri digunakan untuk mengembangkan alat untuk memperbaiki postur tubuh pekerja. Alat baru yang bisa digunakan untuk merendam dan menggiling ini memiliki pijakan kaki, sehingga pekerja tidak perlu menjangkau terlalu jauh di atas dada untuk memindahkan kedelai ke penggilingan. Stasiun perendaman dan stasiun penggilingan keduanya mencapai skor 24, dengan tingkat yang rendah, menunjukkan bahwa tidak ada stasiun yang memerlukan perbaikan. Pengurangan waktu setelah perbaikan postur tubuh adalah 3,33 detik untuk stasiun penggilingan dan 2,08 detik untuk stasiun perendaman.

Keywords: anthropometri, kedelai, perbaikan postur, Workplace Ergonomic Risk Assessment

INTRODUCTION

Incorrect work posture can contribute to musculoskeletal diseases (MSDs). MSDs are the most frequent complaints reported by workers in many industries. They can be fatal if not thoroughly investigated (Sugiono et al., 2018; Rohani et al., 2018). Repetition of action creates stress, minor trauma, and wear and tear on the joints, muscles, and tendons, which over time,

results in pathology in the affected area (Caputo et al., 2019; Mansoorian et al., 2019). MSDs can be prevented and minimized with an ergonomic review (Joshi & Deshpande, 2020). Ergonomics is the study of the systems in which humans, work facilities, and the surrounding environment interact, with the primary purpose of changing the working environment so that humans are comfortable performing their duties (Bitan et al., 2019).

Ergonomically applied human work positions can minimize fatigue and workload, as well as health concerns related to work postures, and provide long-term comfort for workers by analyzing work postures (Bidiawati et al., 2018). The tool's design must be developed with workers to prevent physical complaints. Body posture was evaluated using the Workplace Ergonomic Risk Assessment (WERA) method. The WERA method incorporates five body areas and six physical risk factors, i.e., posture, repetition, force, vibration, contact pressure, and labor duration (Zein et al., 2015; Pratiwi et al., 2019b). This technique assesses the shoulders, wrists, back, neck, and feet. Workplace observations are conducted to obtain the WERA method data via videotaping or recording activities (Sukadarin et al., 2016; Pratiwi et al., 2019b). The WERA is an assessment method that provides a suitable direction for evaluating risk during a work job. This evaluation system only utilizes a paper-and-pen and requires no special equipment (Rajendran et al., 2021). This study aims to identify work postures to determine the work risk level before and after the improvement using the WERA method and improve the workstation by designing ergonomic tofu production tools.

METHODS

An empirical study was carried out at a Sumedang tofu small enterprise at Rimbo Panjang, Pekanbaru, Indonesia. Workers at the Sumedang tofu small enterprise do their work by bending over, resulting in pain in the neck, back, and waist. A bucket is used to soak soybeans. The first stage is carried out between 04.00 a.m. and 09.00 a.m. up to 55 kg with a bucket capacity of 11 kg, and the second stage is carried out between 11.00 a.m. and 02.30 p.m. up to 22 kg. After being soaked, the soybeans are fed into the grinding machine in 10-kilogram increments, repeated 1-2 times per minute. The grinding procedure requires 16 to 22 minutes. This process is repeated until all

of the soaked soybeans have been ground. Workers complete their tasks by bending over, producing discomfort in the neck, back, and waist. The worker transfers soybeans to the milling machine with his hands extending too high because it is above their chests 132 centimeters, resulting in shoulder and hand pain. Based on the Sumedang tofu small enterprise condition, work postures were identified at soaking and milling workstations to determine the work risk level before and after the improvement using the WERA method. The condition of the enterprise was then improved by designing ergonomic tofu production tools.

Preliminary Observation Using Nordic Body Map (NBM) Questionnaire

The nordic body map is one of the most commonly used questionnaires in the industry to collect information on the causes of musculoskeletal disorders. A questionnaire on NBM contains 27 questions on complaints felt in body parts, consisting of the neck, shoulders, upper back, elbows, lower back, wrists, waist, knees, and heels. This questionnaire also includes body parts illustrations to facilitate respondents' comprehension of the questions posed (Chin et al., 2019; Hasanuddin et al., 2019). Work performed in non-adaptive work environments causes discomfort to the worker's body parts, according to preliminary findings obtained using the NBM questionnaire. The questionnaires were given to all three male workers at a Sumedang tofu small enterprise with age between 28 and 36. It revealed that 66.67 percent complained of pain in the upper and lower neck, 66.67 percent on the left shoulder, 100 percent on the right shoulder, back, and waist, and 100 percent on the left shoulder, back, and waist.

Work Ergonomic Risk Assessment (WERA)

The WERA method can identify occupations with the highest MSD risk (Rahman et al., 2011a). WERA is a rapid screening method that identifies physical risk factors for musculoskeletal illnesses related to the workplace. WERA evaluation consists of six physical risk variables, including posture, repetition, strength/force exertion, vibration, contact pressure, and work duration, which affect five key body parts, namely the shoulders, wrists, back, neck, and legs (Rahman et al., 2011b). The final result of the WERA assessment reflects action levels that show how prevalent potential MSDs are in the assessed work

as the basis of work postures improvement and to build a good work system, particularly for jobs that may cause MSDs (Sugiono et al., 2019). The data consisted of videos of manufacturing operations, photographs of work postures, and interviews with workers. WERA was used in this study to determine the work risk level before and after the improvement.

The initial step for calculating work posture using the WERA was identifying body posture on the shoulder (posture and repetition), wrist (posture and repetition), back (posture and repetition), neck (posture and repetition), feet (posture and duration of work), strength (strength and posture), vibration (vibration and posture), contact pressure (contract pressure and posture), and duration of work (duration of work and strength). The next step was the WERA work posture evaluation. The low action level category with a score between 18 and 27 indicates that the task can be accepted. The medium action level with a score between 28 and 44 indicates that the task requires further investigation and modification. The high activity level, with a score between 45 and 54, indicates that the task is unacceptable and must be revised immediately (Pratiwi et al., 2019a).

The procedure for using WERA is explained in five steps (Rahman et al., 2011b):

1. Observing the task/job to formulate a general ergonomic workplace assessment, including the impact of work layout and environment, use of equipment, and worker behavior concerning risk-taking. If possible, the data is recorded using a photograph or a video camera.
2. Selection of task/job for assessment. Deciding which task/job to analyze from the observation in step one. The following criteria can be used:
   a. Most frequently repetitive work of task/job
   b. Extreme, unstable, or awkward posture
   c. The task/job is the cause of the discomfort, according to worker
   d. Required the greatest forces, contact stress, and use of vibration tool.
3. Scoring each item of risk factor using the WERA tool (Figure 1). The scoring includes:
   a. Part A (Item No. 1-5) consists of five main body areas, including the shoulder, wrists, back, neck, and legs. This part cover two physical risk factor for each body part, including posture and repetition.
   b. Part B (Item No. 6-9) consists of four physical risk factors: forcefulness, vibration, contact stress, and task duration.
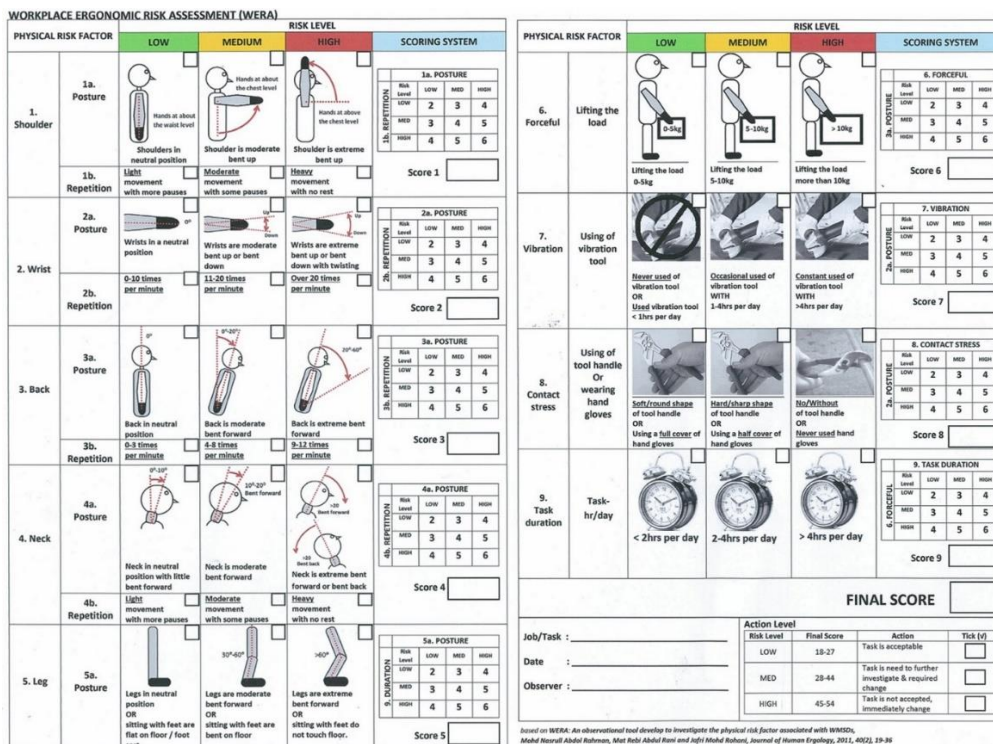

Figure 1. WERA Tool (Rahman et al., 2011b)

4. Calculation of the score for each item (Part A and B) and the total final score. Giving the numbers at the crossing point of every pair of circled numbers (columns vs. rows). After scoring for each item of risk factor (Item No. 1-9), the total final score is calculated (Figure 1).

5. The total final score will be indicated whether the task is accepted (final score of 18-27, low-risk level), further investigation and requires a change (final score of 28-44, medium-risk level), or not accepted, which needs to be immediately changed (final score of 45- 54, high-risk level).

Design New Ergonomic Tool

Based on previous stages of this research, a new ergonomic tool was created. Anthropometric data were required to design a new ergonomic tool. This information was collected from all three Sumedang tofu small enterprise employees. The 5th, 50th, and 95th percentiles were subsequently calculated (Fiana et al., 2019). The term 'percentile' refers to a scale of 100 that indicates a score's distribution is equal to or greater than that score. The use of percentiles in design significantly impact on the design of tools and their ergonomic usability for users. After determining the utilized percentile, the size of the percentile score was obtained. The size of the percentile score will be used to determine the ergonomic tool's design data. The product was created using predetermined anthropometry and percentile scores (Shahriar et al., 2020).

RESULTS AND DISCUSSION

**Worker Physical Risk Assessment Before Body Posture Improvement**

Soaking Station

The WERA method at the soaking workstation before the body posture improvement was carried out by providing angles on the shoulders, wrists, back, neck, and legs formed by the worker when working at the soaking station. The posture before improving the working system at the soaking station can be seen in Figure 2.

The WERA tool (Figure 1) was then utilized to conduct the subsequent evaluation (Hasheminejad et al., 2021). Based on Figure 2, worker's shoulders formed a moderately bowed angle of 40.30° (Figure 2), or their hands were at

chest level (Rahman et al., 2011b). Repetition received a poor grade due to light movements and more pauses. Medium shoulder posture and low repetition yielded a score of 3 on a scoring or grading scale. The working posture became important if the operator's wrist formed a downward angle of 73.60° or was in an excessively flexed position. The posture movements were performed 1-2 times per minute, and repetition was assigned a low score between 0 and 10 per minute.

When the back of the operator was flexed forward, it formed an angle of 90.00° forward, and the work posture was highly important. With posture movements done 1-2 times per minute, an assessment of repetition yielded a low score of 0 to 3 per minute. The high back posture and low repetition received a score of 4 on a scoring system. The operator's neck formed an angle of 27.30° forward, or the neck bent forward extremely, indicating a high score operator's work posture. The operator's leg formed an angle of 31.80° to bend forward, indicating that the operator's work posture was a medium score
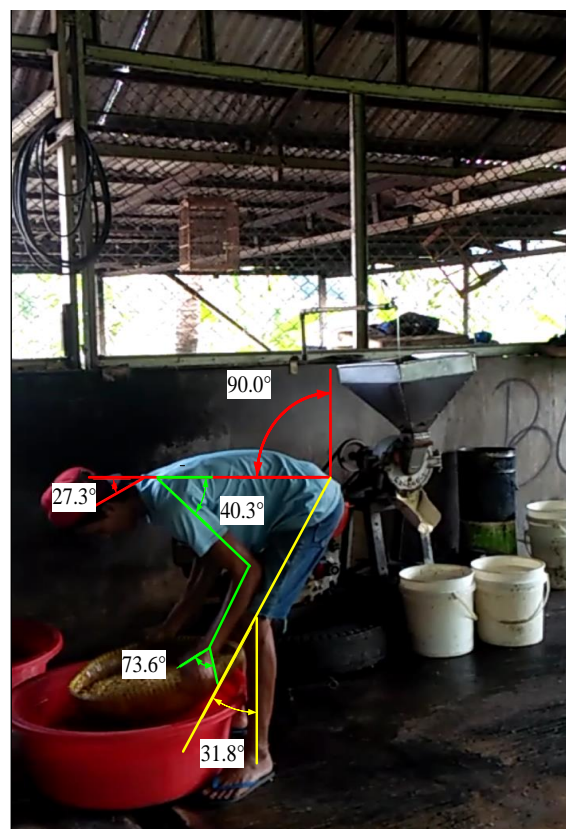
Figure 2. Soaking Station Worker Body Posture Before Body Posture Improvement

The Improvement of Work…

The hoisted load consisted of 10 kilograms of soybean. Hence, the load category lifted was medium (5-10 kg). The operator did not utilize a tool with vibration when performing work. Hence, it was rated poorly. When the operator's wrist created an angle of 73.60° downwards, or the wrist was in a position of excessive flexion downwards, the work posture was of considerable importance. The duration of work was given a poor score since it was completed in less than 2 hours per day, averaging 18.33 seconds to lift soybeans. The final score for work posture (Figure 3) was determined by summing all the scores for work posture to get a total of 35. The activity level category on work posture, with a score of 35, was the work that needs further investigation and improvement.

Milling Station

Based on Figure 4, the shoulders formed an angle of 90.0°, or the shoulders were bent upwards in an extreme position of the hands above chest level, and the work posture had a high score. Based on Figure 4, the shoulders formed an angle of 90.0°, or the shoulders were bent upwards in an extreme position of the hands above chest level, and the work posture had a high score. A low score was given to the repetition with light movements with more pauses. The wrist was bent to an extreme or bent to form an angle of 59.70°, so the work posture had a high score. A low score was given to the repetition of 0-10 per minute, with posture movements performed 1-2 times per

minute. A scoring system was carried out, and a score of 4 was obtained from the high wrist posture and low repetition. The operator's back formed an angle of 0° where the back was in a neutral position. Hence, the work posture had a low score. A low score was given to the repetition of 0-3 per minute, with posture movements performed 1-2 times per minute. A scoring system was carried out, and a score of 2 was obtained from the low back posture and low repetition. The neck of the operator formed an angle of 30.30° in a forward bent position, so the work posture had a high score, while the operator's legs formed an angle of 0° when the neutral leg was upright, so the work posture had a low score.

The load lifted was 10 kg of soybeans, then the category of load lifted was medium, i.e., 5-10 kg (Rahman et al., 2011b). The operator did not use a tool with vibration when doing the task, so it was given a low score. The operator's wrist formed an angle of 59.70° upwards, or the wrist was bent upwards in an extreme manner, so the work posture had a high score. The duration of work was given a low score because it was carried out less than 2 hours per day, with an average time of 7.33 seconds to put soybeans. The final work posture score was done by adding all the work posture scores to get a score of 31 (Figure 5). The activity level category on work posture, with a score of 31, was the work that needs further investigation and improvement.

Figure 3. Exposure score before work system improvement using WERA in soaking workstation

Figure 4. Milling Station Worker Body Posture Before Body Posture Improvement

Figure 5. Exposure Score Before Work System Improvement using WERA in Milling Work Station

New Ergonomic Tool

The new ergonomic tool designed for soaking and milling stations utilized male Indonesian Anthropometric data from 28 to 36 years of age. Improvements have been made to the tool's design based on a water bath concept with legs and a drain hose to separate soybeans from the water easier. Improvements to the design consider a

normal working posture with a standing working position so that workers were not required to bend over during the soaking and milling process. Combining the soybean soaking and milling station with footrests made it unnecessary for workers to reach 132 centimeters above their chests to place the beans on the soybean grinding machine. Improvements were also made to reduce the distance of soybean transportation, as illustrated in Figure 6. Table 1 displays the anthropometric data used at the soybean soaking and milling station following the enhancement of the work system.

The improvements were carried out by designing an ergonomic soybean soaking station using anthropometric data from three male workers aged 28-36 years of Sumedang tofu small enterprise. The design considered a normal working posture (Ya'Acob et al., 2018; Sharma & Singh, 2014) was a standing position where workers do not bend over during the soaking process and do not need to reach too high in the lifting process to the milling machine. The tools improvements designed using the principle of a water bath with legs and a drain hose make it easier to separate soybeans from water. Improvements to the tool's design were carried out by combining the soybean soaker with a footrest so that workers do not have to reach too high above the workers' chests at the milling station and shorten the distance of moving soybeans.
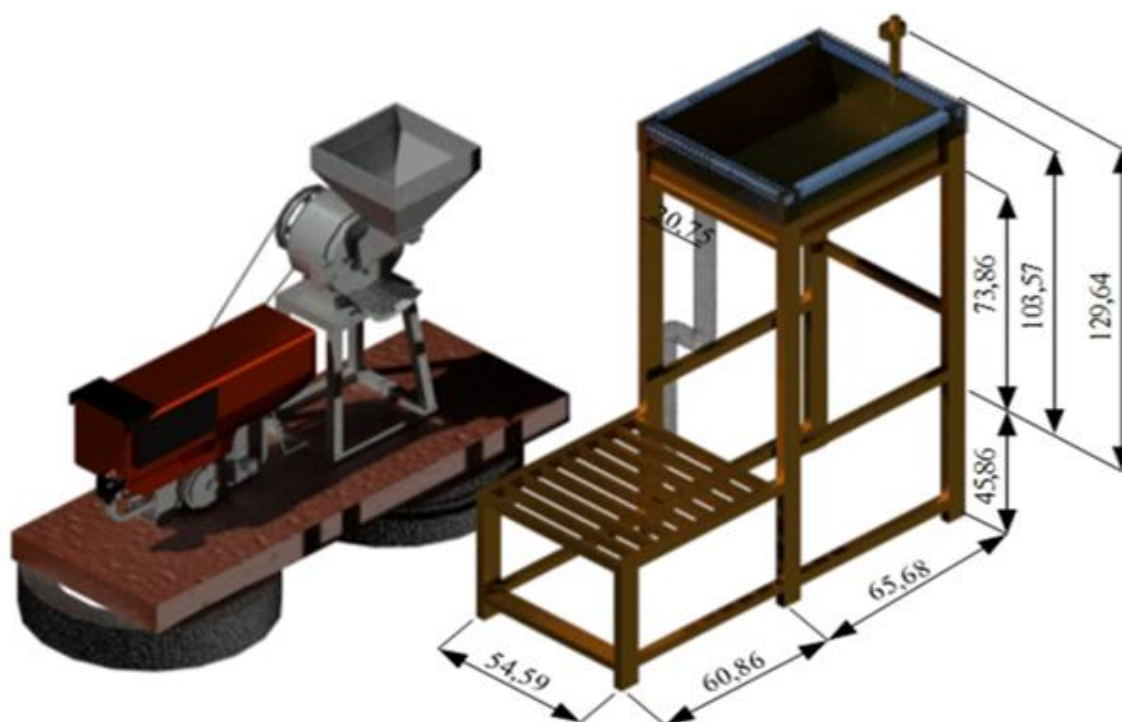
Figure 6. Soybean Soaking Station After Work System Improvement

Table 1 Anthropometric data of soybean soaking station after work system improvement

No	Anthropometric Data	Percentile	Size Body Dimensions (cm)
1	Shoulder Width	95	54.59
2	Shoulder Height	5	129.64
3	Standing Elbow Height	50	103.57
4	Forward Arm Length	50	65.68
5	Hand Length	50	20.75
6	Shoulder Length to Forehand Grips	50	60.86
7	Bone Height	50	73.86
8	Popliteal Height	50	45.86

Worker Physical Risk Assessment After Body Posture Improvement

<u>Soaking Station</u>

Assessment of the WERA method at the soaking station after the repair was done by giving angles on the shoulders, wrists, back, neck, and legs as shown in Figure 7. The data shows that the operator's shoulder formed an angle of 0.0º or the shoulder position in normal conditions. Hence, the work posture score was low. A low score was given to the repetition with light movements and more pauses. Score 2 was given for the shoulder posture and low repetition. The operator's wrist formed an angle of 13.10º with a moderate risk level or moderate bending, so the work posture was of a medium score. A low score was given to the repetition of 0-10 per minute, with posture movements performed 1-2 times per minute. A score of 3 was obtained from the medium wrist posture score and low repetition.

The operator's back formed an angle of 0.0º, or the back was in a neutral position. Hence, the score for work posture was low. A low score was

given to the repetition of 0-3 per minute, with posture movements performed 1-2 times per minute. A score of 2 was obtained from the low back posture and low repetition. The operator's neck formed an angle of 0.0º, or the neck was in a normal position, so the work posture score was low. The operator's leg forms an angle of 0.0º, or the feet were in a neutral position, so the work posture score was low.

The load lifted was 8 kg of soybeans, so the category of load lifted was medium (5-10 kg). The worker did not use a tool with vibration, so it got a low score. The worker's wrist formed an angle of 13.10° with a moderate risk level or moderate bending, so the work posture score was medium. The work duration was given a low score because it was carried out for less than 2 hours per day, with an average time of lifting soybeans of 16.25 seconds. The final work posture score was done by adding up all the work posture scores, and a score of 24 was obtained. The activity level category on work posture with a score of 24 was accepted and did not need to be repaired.

Figure 7. Soaking Station Worker Body Posture After Body Posture Improvement

Milling Station

After the workstation improvement, the WERA method assessment at the milling station provided angles on the shoulders, wrists, back, neck, and legs, as seen in Figure 8. The shoulder of a soybean milling worker formed an angle of 0.0º or the shoulder position in normal conditions. It indicated that the work posture score was low. A low score was given for light movements with more pauses involving repetition. Based on the low shoulder posture and low repetition score, a scoring system assigned a score of 2 points.

The worker's hand formed an angle of 11.60°, with a moderate risk level or moderate bending. The work posture score was medium. Posture movements are performed 1-2 times per minute, and a low score was given to the repetition of 0-10 per minute. Medium wrist posture and low repetition yielded a score of 3. The operator's back formed an angle of 0.0º, or the back was in a neutral position, so the work posture was low. A low score was given to the repetition of 0-3 per minute, with posture movements performed 1-2 times per minute. A score of 2 was obtained from

the low back posture and low repetition. The worker's neck formed an angle of 8.10° forward, or the neck was in a neutral position with a slight bend, then the work posture was given a low score, while the worker's leg formed an angle of 0.0º or in a neutral position, so the work posture score was low.

The load lifted was 8 kg soybeans, so the category was medium (5-10 kg). The worker did not use a tool with vibration when doing work, so it was given a low score. The worker's wrist formed an angle of 11.60° with a moderate level of risk or moderate bending, so the work posture score was medium. The duration of work was given a low score because it was carried out less than 2 hours per day, with an average time of placing soybeans was 4 seconds. The final work posture score was 24. It was obtained by adding all the scores. The WERA score between 28 and 44 was included in the medium-level activity. It indicated that the task requires further investigation and modification (Pratiwi et al., 2019a).

Figure 8. Milling Station Worker Body Posture After Body Posture Improvement

Table 2. Soaking and milling station time reduction

Station	The Average Working Duration (seconds)		Time Reduction (seconds)
	Before Body Posture Improvement	**After Body Posture Improvement**	
Soaking	18.33	16.25	2.08
Milling	7.33	4	3.33

Time Reduction

The time reduction at the soaking and milling station is shown in Table 2. Das (2021) found that eliminating the actual steps will enhance 32% productivity in time and recommends ergonomic intervention to reduce biomechanical stress among brickfield workers.

CONCLUSIONS

Work posture analysis has been carried out using the WERA method at the soaking station with a score of 35 and the milling station with a score of 31. The scores were at a medium level, so improving the soaking and soybean milling stations is necessary. Improvements have been made to the tool by combining the soybean soaker with a footrest, so the workers do not need to reach too high above the workers' chests at the milling station and shorten the distance of moving soybeans. The analysis after improvement using the WERA method showed a score of 24 at the milling station and 24 at the soaking station, with both classified as low level. The activity level category on work posture with those scores was accepted, and both workstations did not need to be further improved. Time reduction after the improvement was 3.33 seconds at the milling station and 2.08 seconds at the soaking station.

References

Bidiawati, A., Setiawati, L., & Kurnia, Y. (2018). Tools design of bread production process to minimize musculoskeletal disorders based on OCRA method. *International Journal of Engineering & Technology*, *7*(2.29), 106. https://doi.org/10.14419/ijet.v7i2.29.13139

Bitan, Y., Ramey, S., & Milgram, P. (2019). Ergonomic design of new paramedic response bags. *Applied Ergonomics*, *81*(June), 102890. https://doi.org/10.1016/j.apergo.2019.102890

Caputo, F., Greco, A., Fera, M., & Macchiaroli, R. (2019). Workplace design ergonomic validation based on multiple human factors assessment methods and simulation. *Production & Manufacturing Research*, *7*(1), 195–222.

https://doi.org/10.1080/21693277.2019.1616631

Chin, J., Iridiastadi, H., Shu-chiang, L., & Fadil, S. (2019). *Workload Analysis by Using Nordic Body Map , Borg RPE and NIOSH Manual Lifting Equation Analyses : a Case Study in Sheet Metal Industry Workload Analysis by Using Nordic Body Map , Borg RPE and NIOSH Manual Lifting Equation Analyses : a Case Study in Shee*. 4–10. https://doi.org/10.1088/1742-6596/1424/1/012047

Das, B. (2021). Improved work organization to increase the productivity in manual brick manufacturing unit of West Bengal, India. *International Journal of Industrial Ergonomics*, *81*(March 2020), 103040. https://doi.org/10.1016/j.ergon.2020.103040

Fiana, S., Sugandi, W. K., Thoriq, A., & Yusuf, A. (2019). Analisis antropometri petani dan aplikasinya pada desain alat pemanen manggis. *Jurnal Ergonomi Indonesia (The Indonesian Journal of Ergonomic)*, *5*(1), 25–31.

Hasanuddin, I., Fahrizal, R., & Asmadi, D. (2019). Analysis of transport workers' postures in the loading process of manual material handling activities by using the photogrammetric method. *IOP Conference Series: Materials Science and Engineering*, *523*(1). https://doi.org/10.1088/1757-899X/523/1/012081

Hasheminejad, N., Choobineh, A., Mostafavi, R., Tahernejad, S., & Rostami, M. (2021). Prevalence of musculoskeletal disorders, ergonomics risk assessment and implementation of participatory ergonomics program for pistachio farm workers. *Medicina Del Lavoro*, *112*(4), 292–305. https://doi.org/10.23749/mdl.v112i4.11343

Joshi, M., & Deshpande, V. (2020). A systematic review of comparative studies on ergonomic assessment techniques International Journal of Industrial Ergonomics A systematic review of comparative studies on ergonomic assessment techniques. *International Journal of Industrial Ergonomics*, *74*(September), 102865. https://doi.org/10.1016/j.ergon.2019.102865

Mansoorian, M., Ghasemi, M. S., & Dehghan, N. (2019). Designing a new ergonomic student backpack. *Journal of Pharmaceutical Research International*, *September*, 1–7.

https://doi.org/10.9734/jpri/2019/v29i530249

Pratiwi, I., Munfi'ah, Fitriadi, R., & Sufa, M. F. (2019). Evaluation of work posture in sohun noodles workers using OWAS and WERA method. *International Journal of Innovative Technology and Exploring Engineering*, *8*(11), 1788–1793. https://doi.org/10.35940/ijitee.K1767.0981119

Pratiwi, I., Setyowati, R., Alghofari, A. K., & Fitriadi, R. (2019). Work posture analysis using WERA and NERPA methods in batik workers. *Test Engineering and Management*, *81*(December 2019), 6625–6633.

Rahman, M. N. A., Rani, M. R. A., & Rohani, J. M. (2011a). WERA: An observational tool develop to investigate the physical risk factor associated with WMSDs. *Journal of Human Ergology*, *40*(1–2), 19–36.

Rahman, M. N. A., Rani, M. R. A., & Rohani, M. J. (2011b). *Workplace Ergonomic Risk Assessment (WERA)*. http://ergo.human.cornell.edu/CUErgoTools/WERA/WERA Tool User Guide.pdf

Rajendran, M., Sajeev, A., Shanmugavel, R., & Rajpradeesh, T. (2021). Ergonomic evaluation of workers during manual material handling. *Materials Today: Proceedings*, *46*(xxxx), 7770–7776. https://doi.org/10.1016/j.matpr.2021.02.283

Rohani, J. M., Adeyemi, A. J., Aziz, R. A., & Rani, M. R. A. (2017). The inter-rater and intra-rater reliability analysis of workplace ergonomic risk assessment. *Jurnal Teknologi*, *80*(1), 53–59. https://doi.org/10.11113/jt.v80.10285

Shahriar, M. M., Parvez, M. S., & Lutfi, M. (2020). A survey of hand anthropometry of Bangladeshi

agricultural farm workers. *International Journal of Industrial Ergonomics*, *78*(November 2019), 102978. https://doi.org/10.1016/j.ergon.2020.102978

Sharma, R., & Singh, R. (2014). Work-related musculoskeletal disorders, job stressors and gender responses in foundry industry. *International Journal of Occupational Safety and Ergonomics*, *20*(2), 363–373. https://doi.org/10.1080/10803548.2014.11077053

Sugiono, S., Budiprasetya, A., & Efranto, R. (2019). Reducing musculoskeletal disorder (MSD) risk of wiring harness workstation using workplace ergonomic risk assessment (WERA) method. *Przegląd Naukowy Inżynieria i Kształtowanie Środowiska*, *27*(4), 536–551. https://doi.org/10.22630/PNIKS.2018.27.4.50

Sukadarin, E. H., Deros, B. M., Ghani, J. A., Mohd Nawi, N. S., & Ismail, A. R. (2016). Postural assessment in pen-and-paper-based observational methods and their associated health effects: a review. *International Journal of Occupational Safety and Ergonomics*, *22*(3), 389–398. https://doi.org/10.1080/10803548.2016.1156924

Ya'acob, N. A., Abidin, E. Z., Rasdi, I., Rahman, A. A., & Ismail, S. (2018). Reducing work-related musculoskeletal symptoms through implementation of Kiken Yochi training intervention approach. *Work*, *60*(1), 143–152. https://doi.org/10.3233/WOR-182711

Zein, R. M., Halim, I., Azis, N. A., Saptari, A., & Kamat, S. R. (2015). A survey on working postures among Malaysian industrial workers. *Procedia Manufacturing*, *2*(February), 450–459. https://doi.org/10.1016/j.promfg.2015.07.078