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Risk Analysis of Work Posture in Manual Welding Activities Using The Workplace Ergonomic Risk Assessment Method at UD. Inti Tekindo

Dewi Hartati*, A.Amri*, Cut Ita Erliana

Industrial Engineering Department, Universitas Malikussaleh, Lhokseumawe, Indonesia
***Corresponding author**: dewihartatidewi451@gmail.com, iramri@unimal.ac.id

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Abstract
Manual welding activities at UD. Inti Teknindo are carried out with work postures that are not very ergonomic, such as bending over, squatting, and leaning down for long periods, which can potentially cause musculoskeletal disorders (MSDs). This study aims to determine the risk level of welding workers' postures using the Workplace Ergonomic Risk Assessment (WERA) method and to provide improvement suggestions to reduce the risk of MSDs. The study was conducted on 4 welding workers using observation, documentation, interviews, the Nordic Body Map (NBM) questionnaire, and anthropometric measurements. The NBM questionnaire results showed that all workers were at high-risk levels with scores of 71–73, indicating complaints in the back, waist, neck, shoulders, and wrists. The analysis using the WERA method showed that worker 1 scored 45, worker 2 scored 45, worker 3 scored 45, and worker 4 scored 44, so all workers fall into the high-risk category and need corrective action. Based on this analysis, a work facility in the form of an Adjustable Welding Support Stand is proposed, designed according to the workers' anthropometric data with a stand height of 97.37–101.62 cm and a work area width of 44.3 cm. The evaluation results of the proposed design show the WERA score dropped to 27, which falls into the low-risk category. Therefore, this proposed work facility can improve working posture, reduce the risk of MSDs, and increase comfort and safety for welding workers at UD. Inti Teknindo.
Keywords: *ergonomics, manual welding, workplace ergonomic risk assessment (wera)*

Abstrak
Aktivitas pengelasan manual di UD. Inti Teknindo dilakukan dengan postur kerja yang kurang ergonomis, seperti membungkuk, jongkok, dan menunduk dalam waktu yang lama sehingga berpotensi menimbulkan keluhan *musculoskeletal disorders* (MSDs). Penelitian ini bertujuan untuk mengetahui tingkat risiko postur kerja pekerja pengelasan menggunakan metode *Workplace Ergonomic Risk Assessment* (WERA) serta memberikan usulan perbaikan untuk mengurangi risiko MSDs. Penelitian dilakukan terhadap 4 orang pekerja pengelasan dengan menggunakan metode observasi, dokumentasi, wawancara, kuesioner *Nordic Body Map* (NBM), dan pengukuran antropometri. Hasil kuesioner NBM menunjukkan seluruh pekerja berada pada tingkat risiko tinggi dengan skor 71–73, yang mengindikasikan adanya keluhan pada bagian punggung, pinggang, leher, bahu, dan pergelangan tangan. Hasil analisis menggunakan metode WERA menunjukkan bahwa pekerja 1 memperoleh skor 45, pekerja 2 memperoleh skor 45, pekerja 3 memperoleh skor 45, dan pekerja 4 memperoleh skor 44, sehingga seluruh pekerja berada pada kategori risiko *high* yang memerlukan tindakan perbaikan. Berdasarkan hasil analisis tersebut, diusulkan fasilitas kerja berupa *Stand* Penyangga Pengelasan *Adjustable* yang dirancang berdasarkan data antropometri pekerja dengan tinggi stand 97,37–101,62 cm dan lebar area kerja 44,3 cm. Hasil evaluasi usulan menunjukkan skor WERA menurun menjadi 27 dengan kategori risiko *low*. Dengan demikian, usulan fasilitas kerja tersebut mampu memperbaiki postur kerja, mengurangi risiko MSDs, serta meningkatkan kenyamanan dan keselamatan kerja pekerja pengelasan di UD. Inti Teknindo.
Kata Kunci: *ergonomi, pengelasan manual, workplace ergonomic risk assessment (wera)*

1. Introduction

The growth of the manufacturing industry is driving the increasing demand for welding processes, especially in small and medium-sized welding workshops. Welding is the process of joining materials, both metal and non-metal, using heat energy (at a certain temperature). It can be done with or without applying pressure and may use filler material or not. Besides joining, welding is also used to fill holes or add thickness to certain surfaces. The welding process itself is divided into several types, one of which is manual welding [1]. Manual welding is the process of joining two or more metals into a single, permanent piece using a heat source (mainly an electric arc) and is done directly by an operator without full automation. In manual welding, the operator holds the electrode (welding rod) and welding tools directly to create an electric arc that melts the base metal and filler material, causing them to fuse or join as they cool and solidify. A common manual welding method is Shielded Metal Arc Welding (SMAW), where a coated electrode (welding rod) is used to produce the electric arc and a protective gas that prevents air contamination in the weld area [2].

UD Inti Teknindo is a trading business that operates in the field of iron welding, with final products including fences, canopies, tables, and various types of racks. This business was established in 2020 and currently has 6 workers, 4 in the welding section and 2 in the finishing section. At UD, there are 3 workstations: cutting, welding, and finishing. The working hours at UD are 9 hours per day. Production at UD is done by order, meaning production is carried out when there is an order. Based on the results of the Nordic Body Map (NBM) questionnaire recap, which can be seen in Appendix I, it is known that all workers are at high risk with scores of 72 and 71. These results show that workers have experienced musculoskeletal complaints in several body parts such as the back, waist, neck, and wrists. Therefore, immediate improvements are needed. The WERA method is highly recommended in this study because it can assess ergonomic risks more comprehensively according to the characteristics of manual welding activities. During the welding process, workers often work in bent-over, squatting, or leaning postures, and hold static positions for certain periods. In addition, the activities are repeated and involve continuous use of the shoulders, hands, back, and neck. These conditions have the potential to cause musculoskeletal complaints among workers.

Ergonomics is a branch of science that discusses the use of information related to human abilities, limitations, and behavior in designing a good work system so that the desired goals are achieved through efficient, effective, comfortable, and safe work [3]. Considering the many work injury cases caused by environmental factors, a job design that doesn't take ergonomic aspects into account can have negative effects on both workers and the company [4]. Guidelines for applying ergonomics in the workplace using ergonomic principles. The 12 recommended ergonomic principles are as follows [5]. Ergonomic risks that workers might face include work duration, frequency, workload, job sequence, job priorities, and working posture; risks related to work equipment include work dimensions, shapes, workstation design, and the placement of facilities used to support work like monitors, CPUs, keyboards, mice, drawing tables, desks, chairs, phones, and document holders; risks related to the work environment include the dimensions, size, and layout of the workspace, while risks related to individuals or workers include lifestyle, health status, and musculoskeletal complaints experienced by workers [6].

This process produces a strong joint that can have strength equal to or even greater than the original material [7]. Along with advances in technology, welding in construction is part of industrial development. Nowadays, many construction projects use metal, so welding processes are often involved, one of them being Shielded Metal Arc Welding (SMAW) [8]. The Nordic Body Map (NBM) is a measurement method used to identify skeletal muscle complaints, using a worksheet or body map that is easy to understand, simple, and quick to apply [9]. NBM results can estimate the type and level of discomfort, fatigue, and pain in muscle parts felt by workers, by looking at and analyzing body maps taken from filling out the NBM questionnaire, ranging from feeling uncomfortable to very painful [10]. Musculoskeletal Disorders (MSDs) are issues that a person feels in the skeletal muscles, and the complaints are felt gradually, ranging from very mild to very painful. The complaints, such as damage to ligaments, joints, and tendons, can occur if the muscles are subjected to static loads for a long time repeatedly [11]. The general risk factors for musculoskeletal disorders include awkward body posture, repetitive work movements, handling of materials, mechanical compression, vibration, extreme temperatures, glare, inadequate lighting, and exposure duration. Meanwhile, the individual risk factors for musculoskeletal disorders are age, gender, physical activity, BMI, and smoking habits [12].

Work posture is the position of the body while working that arises from active movements of several body parts like the head, back, and spine as a relative orientation of body parts to space [13]. Work posture is the movement a worker makes while doing a job [14]. The WERA method has a scoring system and action levels that provide guidance on risks and the need to carry out a more detailed assessment. In implementing the WERA method concept, there are several steps as follows [15].

WERA is considered suitable because it not only assesses body posture but also takes into account other important factors like work duration, movement frequency, work style or load, and work vibrations, especially since workers use their tools for more than 4 hours a day. This method can also evaluate several key body parts at once, such as shoulders, wrists, back, neck, and legs, which are the most commonly used parts during manual welding activities. With this more comprehensive assessment, the work risk analysis results better reflect the actual conditions in the field. Based on this, the author is interested in this research titled 'Analysis of Work Posture Risk in Manual Welding Activities Using the Workplace Ergonomic Risk Assessment (WERA) Method at UD. Inti Teknindo.' Through this study, the author hopes to provide improvement recommendations that can reduce workers' physical burden, minimize repetitive movements, and increase work efficiency and productivity. It is expected that this research can contribute to creating a safer and healthier work environment, while also improving production quality at the company.

2. Material and Methods

2.1 Study Design

This study employed a quantitative descriptive approach to evaluate ergonomic risks associated with manual welding activities at UD. Inti Teknindo, Lhokseumawe, Indonesia. The research focused on four welding operators involved in the fabrication of metal storage racks. The study was conducted through direct observation of working postures, administration of the Nordic Body Map (NBM) questionnaire, anthropometric measurements, interviews, and workplace documentation. The ergonomic risk assessment was performed using the Workplace Ergonomic Risk Assessment (WERA) method, while anthropometric analysis was conducted to develop an ergonomic workstation design. The proposed adjustable welding support stand was subsequently evaluated by comparing WERA scores before and after the proposed improvement.

2.2 Participants and Data Collection

The participants consisted of four manual welding operators working at the welding station of UD. Inti Teknindo. Since the number of welding workers was limited, all operators were included as research subjects. Primary data were collected through workplace observation, interviews, documentation, Nordic Body Map questionnaires, and anthropometric measurements. The observations focused on workers' postures during welding activities, while the NBM questionnaire was used to identify musculoskeletal complaints experienced by each worker. Anthropometric measurements included standing waist height and shoulder breadth, which were used as the basis for designing the proposed workstation. Secondary data included company information and supporting literature related to ergonomics and manual welding activities.

2.3 Ergonomic Risk Assessment

Ergonomic risk assessment was conducted using the Workplace Ergonomic Risk Assessment (WERA) method. This method evaluates nine ergonomic risk factors, namely shoulder posture, wrist posture, back posture, neck posture, leg posture, force, vibration, contact stress, and task duration. Each operator's working posture was observed directly during manual welding activities, and the corresponding WERA scores were assigned according to the assessment worksheet. The total score determined the ergonomic risk category, which was classified as low, medium, or high risk. The assessment results were used to identify critical ergonomic problems requiring corrective action.

2.4 Anthropometric Measurement and Workstation Design

Anthropometric measurements were collected from all participating workers to ensure that the proposed workstation accommodated their physical characteristics. Standing waist height and shoulder breadth were selected as the primary design dimensions because they directly influence the working height and width of the welding support stand. The anthropometric data were analyzed through data uniformity testing, data adequacy testing, and percentile calculations. Based on these analyses, an adjustable welding support stand was designed using AutoCAD software to improve workers' posture during manual welding operations.

2.5 Data Analysis

The collected data were analyzed descriptively. Nordic Body Map questionnaire results were summarized to identify the prevalence of musculoskeletal complaints among welding workers. Ergonomic risk levels were determined using the WERA scoring system. Anthropometric data were statistically analyzed to determine appropriate design dimensions for the proposed workstation. Finally, the effectiveness of the proposed adjustable welding support stand was evaluated by comparing WERA scores before and after the workstation improvement to determine the reduction in ergonomic risk.

3. Results and Discussion

The results showed that all four manual welding workers at UD. Inti Teknindo experienced a high ergonomic risk. The Nordic Body Map (NBM) assessment produced scores ranging from 71 to 73, indicating high musculoskeletal complaints, particularly in the neck, shoulders, back, waist, and wrists. Furthermore, the Workplace Ergonomic Risk Assessment (WERA) showed scores of 44–45, classifying all workers as high risk and requiring immediate corrective action. To reduce ergonomic risk, an Adjustable Welding Support Stand was designed based on workers' anthropometric data. The proposed design reduced the WERA score to 27 (low risk), indicating that the workstation can improve working posture, reduce MSD risk, and enhance worker comfort and safety.

Nordic Body Map (NBM) Assessment

The Nordic Body Map (NBM) questionnaire was administered to identify musculoskeletal complaints experienced by manual welding workers at UD. Inti Teknindo. The assessment involved four welding workers performing manual welding activities. The results indicate that all workers were classified as having a high risk of musculoskeletal disorders (MSDs), with NBM scores ranging from 71 to 73. According to the NBM classification, these scores require immediate corrective action. The highest complaint scores were reported in the neck, shoulders, upper back, lower back, waist, and wrists. These complaints are mainly caused by prolonged bending, squatting, and repetitive manual welding activities performed throughout the working day. The summary of the NBM assessment is presented in (**Table 1**).

Table 1. Nordic Body Map (NBM)

No	Not Sick	Quite Sick	Sick	Very Sick	Score
1	3	10	13	2	71
2	2	10	14	2	72
3	2	10	14	2	72
4	2	11	13	2	71

Workplace Ergonomic Risk Assessment (WERA)

The ergonomic risk assessment was conducted using the Workplace Ergonomic Risk Assessment (WERA) method by evaluating nine ergonomic risk factors, namely shoulder, wrist, back, neck, leg, force, vibration, contact stress, and task duration.

The assessment results showed that Worker 1 obtained a score of 45, Worker 2 obtained 45, Worker 3 obtained 45, and Worker 4 obtained 44. Based on the WERA action level, all workers were categorized as High Risk, indicating that immediate ergonomic intervention is required. The high ergonomic risk was primarily influenced by excessive trunk flexion, prolonged squatting posture, neck flexion, repetitive hand movements, and long task duration during manual welding activities in (**Table 2**).

Table 2. Assessment recap

worker	score
1	45
2	45
3	45
4	44

Anthropometric Analysis and Proposed Workstation Design

Anthropometric measurements were conducted to determine the dimensions of the proposed ergonomic work facility. The measured body dimensions included standing waist height and shoulder breadth. Before being used in the design process, the anthropometric data were analyzed using data uniformity testing, data adequacy testing, and percentile calculations. The analysis showed that all anthropometric data were statistically acceptable and suitable for workstation design. Based on the anthropometric calculations, the proposed Adjustable Welding Support Stand was designed with an adjustable height of 97.37–101.62 cm and a work area width of 44.3 cm. These dimensions were selected to accommodate workers' body characteristics and maintain a neutral working posture during welding activities in (**Table 3**).

Table 3. Anthropometric Design Dimensions

Anthropometric Dimensions	$\bar{x}$	σ	Percentile		
			5%	50%	95%
TPB	99,5	1,29	97,37	99,5	101,62
LB	43	0,81	41,66	43	44,3

Evaluation of the Proposed Workstation

The effectiveness of the proposed workstation was evaluated by reassessing the workers' postures using the WERA method after implementing the proposed design. The evaluation results showed that the WERA score decreased from 44–45 (High Risk) to 27 (Low Risk). The comparison of WERA scores before and after the proposed improvement is presented in (**Table 4**).

Table 4. Evaluation

Working Condition	WERA Score	Risk Level
Before improvement	44-45	High
After improvement	27	Low

4. Conclusion

This study concludes that manual welding activities at UD. Inti Teknindo expose workers to a high ergonomic risk, with WERA scores ranging from 44 to 45, indicating that immediate corrective actions are required. The high-risk level is mainly caused by awkward working postures, including prolonged bending, squatting, neck flexion, and repetitive upper-limb movements during welding activities. Furthermore, the proposed Adjustable Welding Support Stand, designed based on workers' anthropometric measurements, provides an ergonomic solution to improve working posture. The evaluation of the proposed design reduced the WERA score to 27 (low risk), demonstrating its potential to reduce musculoskeletal disorder (MSD) risks while improving worker comfort and occupational safety during manual welding activities.

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6. References

[1] R. A. Sihombing, “Pengaruh Ampere Pengelasan terhadap Kekuatan Tarik Pelat Baja AISI 1045 Pengelasan Metal Inert Gas (MIG),” Jurnal Teknik Industri, vol. 7, 2024.

[2] Yuslistyari, Eka Indah, and Aden Adhadin. "Perbaikan Postur Kerja Operator Pengelasan dengan Metode Quick Exposure Check (QEC)." *Jurnal INTECH Teknik Industri Universitas Serang Raya* 4.1 (2018): 17.

[3] P. Anisa, “Peran Ergonomi dalam Meningkatkan Efisiensi dan Keselamatan Kerja di Industri,” Jurnal Peran Ergonomi, vol 13, pp. 1–8, 2024.

[4] Purbasari, Annisa, Zaenal Arifin, and Eka Sucandra Adi Putra Hutagalung. "Evaluasi Keselamatan Dan Kesehatan Kerja Dengan Metode Job Safety Analysis Berbasis Prinsip Ergonomi di PT. DSM." *Sigma Teknika* 6.1 (2023): 044-059.

[5] Putra, Kurniawan, and Wahyu Hidayat. "Efektivitas Edukasi Kesehatan dalam Mencegah Penyakit Tidak Menular di Masyarakat." *Primary Journal of Multidisciplinary Research* 2.2 (2026): 39-43.

[6] T. W. Kapoh and D. D. Risma, “Analisis Penggunaan Metode *Workplace Ergonomic Risk Assessment* (WERA) pada Penggorengan Kerupuk,” Jurnal Universitas Sumatra Utara, 2022.

[7] M. H. Asri, “Analisis Pengaruh Variasi Bentuk Sambungan terhadap Karakteristik Mekanis Baja Karbon Rendah Hasil Pengelasan SMAW dan GTAW,” Jurnal Jurusan Teknik Industri, vol. 4, pp. 12201–12219, 2024.

[8] N. F. Dewi, “Identifikasi Risiko Ergonomi dengan Metode *Nordic Body Map*,” Jurnal Sosial Humaniora Terapan, vol. 2, no. 2, 2020.

[9] S. Rahmah and C. K. Herbawani, “Faktor Risiko Penyebab *Musculoskeletal Disorders* (MSDs) pada Pekerja: Tinjauan Literatur,” Jurnal *Engineering* UTU, vol. 6, pp. 1–14, 2022.

[10] B. Aprianto, A. F. Hidayatulloh, and F. N. Zuchri, "Faktor Risiko Penyebab *Musculoskeletal Disorders* (MSDs) pada Pekerja: *A Systematic Review*," Jurnal Ergonomi, vol. 2, pp. 16–25, 2021.

[11] Y. Amran and I. Adibatina, "Analisis Tingkat Pengetahuan Pekerja Konveksi tentang Postur Kerja Ergonomis," Jurnal Ergonomi, vol. 9, no. 1, pp. 40–49, 2023.

[12] N. Nabila, F. N. Balqis, and M. A. G. Siregar, "Analisis Kesesuaian Postur Kerja pada Pekerja Bengkel," *Journal of Industrial Engineering*, vol. 2, pp. 217–223, 2024.

[13] Azriadi, Emon, Resy Kumalasari, and Sri Naldi Fitri. "Perancangan library trolley ergonomis berdasarkan antropometri tubuh manusia." *Journal of Engineering Science and Technology Management (JES-TM)* 2.2 (2022): 125-132.

[14] M. Arif and D. M. Ramadani, "Perancangan Alat Pemanggang Menggunakan Pendekatan Antropometri," Jurnal Teknik Industri, vol. 14, no. 1, pp. 2580–2582, 2021.

[15] R. S. W. Hartanto, "Studi Literatur: Pengembangan Media Pembelajaran dengan *Software AutoCAD*," Jurnal Kajian Pendidikan Teknik Bangunan, vol. 1, no. 1, pp. 1–6, 2016.