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Analysis of Work Posture at PT Kanugrahan Techno Engineering: Application of the REBA Method to Reduce MSDs Risk

Ahmad Zada Hilmi Syifa'[1], Nalan Adha Ilan Ilahi[2], A Dandi Setiawan[3], Egga Jerri Indri Saputri[4], Lulu Rahiba[5], Widya Setiafindari[6]
[1-6]Department of Industrial Engineering, Faculty of Science and Technology,
Universitas Teknologi Yogyakarta, Indonesia
Email: hilmisyifa96@gmail.com [1], ilannalan123@gmail.com [2], ahmaddandi638@gmail.com [3], eggajerrihab@gmail.com [4], lulurahibaasimatillah@gmail.com [5], widyasetia@uty.ac.id [6]

Jl. Glagahsari No. 63 Yogyakarta, D.I. Yogyakarta, Indonesia – 55164
Author correspondence: hilmisyifa96@gmail.com*

***Abstract**. This study aims to analyze the musculoskeletal disorders (MSDs) risk of workers at PT Kanugrahan Techno Engineering involved in grinding activities using the REBA (Rapid Entire Body Assessment) method. The analysis results indicate that grinding activities 1 and 2 have a REBA score of 9, indicating a very high risk, while grinding activity 3 has the highest score of 10, indicating an extreme risk. Grinding activities 4 and 5 have a score of 7, indicating a moderate risk. To reduce these risks, ergonomic aids in the form of a table and chair were designed to support better posture. The production cost of one set of tools is Rp 710,966, with a total cost for 5 sets amounting to Rp 3,554,833.91. The implementation of ergonomic aids is expected to reduce MSDs risks, increase comfort and work efficiency, and improve worker productivity.*

***Keywords:** ergonomic aids, grinding, MSDs, posture, REBA*

1. INTRODUCTION

In the workplace, prolonged exposure to non-ergonomic postures and excessive physical exertion can lead to musculoskeletal disorders (MSDs), causing discomfort in areas such as the back, neck, and other parts of the body. To prevent and manage MSDs, conducting an ergonomic risk assessment is crucial. PT Kanugrahan Techno Engineering, a company specializing in engineering and fabrication, primarily involves grinding activities in its operations. These tasks are often carried out in non-ergonomic positions, such as squatting or bending for extended periods, heightening the risk of musculoskeletal problems. Data collected from five workers revealed that all of them experienced pain in their back, neck, and knees, which are early signs of MSDs. These conditions not only reduce worker productivity but also increase the risk of damage to nerves, bones, ligaments, cartilage, muscles, and tendons.

MSDs refer to conditions that affect the joints, ligaments, muscles, nerves, tendons, and spine, often resulting from excessive strain or uncomfortable working postures (Normania & Rusindiyanto, 2023). These issues are closely linked to high ergonomic risks, particularly in jobs that involve repetitive movements, heavy lifting, or poor working positions (Darussalam, 2022).

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One effective tool for assessing ergonomic risks is the REBA (Rapid Entire Body Assessment) method, developed by Hignett and McAtamney. This approach evaluates the posture, load, and muscle activity of workers during tasks and generates a score that indicates the risk level for MSDs (Hidjrawan et al., 2022). This score helps prioritize areas for improvement and allows the assessment of the effectiveness of ergonomic interventions (Dhifa Farah Miftah & Akmal Suryadi, 2023). The REBA method has been widely used in various industries, including healthcare, manufacturing, and construction, proving successful in redesigning workstations and minimizing injury risks (Kurnia & Sobirin, 2020).

The purpose of this study is to evaluate the work posture during grinding activities at PT Kanugrahan Techno Engineering using the REBA method. The findings from this research are expected to offer practical recommendations to help reduce the risk of MSDs for workers at the company.

2. METHODS

Ergonomics

Ergonomics is the application of scientific knowledge about humans in design to create tools, systems, and work environments that are safe, comfortable, and efficient. The goal of ergonomic design is to improve productivity, safety, and work effectiveness (Hunusalela et al., 2022). Experience shows that activities without considering ergonomics can lead to discomfort, additional costs, illness, and reduced work efficiency (Pratiwi et al., 2021). Poorly designed tools and environments can cause physical strain, fatigue, and injuries. Therefore, ergonomics is essential to be applied in all fields and situations to enhance both worker well-being and organizational success (Krisna Dewanti et al., 2020).

Rapid Entire Body Assessment

Rapid Entire Body Assessment (REBA) is a method used to assess the overall risk of work posture, including static, dynamic, and unstable postures (Akbar et al., 2023). This method analyzes various factors such as body position, load lifted, and muscle activity to determine the risk level of *musculoskeletal disorders* (MSDs). REBA provides a score that helps identify priority improvements and assess the effectiveness of workstation design modifications (Utami & Nugroho, 2023).

The assessment process is carried out using a REBA worksheet as a tool to determine the final score(Cho et al., 2021). This assessment is applied when the worker is performing grinding activities, with the following steps:

a. Steps 1 – 3: Assess the score for the neck, body, and legs.
b. Step 4: Use the scores from Steps 1-3 and refer to the table in this step (Table A).
c. Step 5: Add the load value.
d. Step 6: Add the values from Steps 4 and 5 to determine the Group A score using Table C.
e. Steps 7 – 9: Perform the analysis for the arm and wrist scores.
f. Step 10: Use the results from Steps 7-9 and determine the value using Table B.
g. Step 11: Add the coupling value.
h. Step 12: Add the results from Steps 10 and 11, then determine the value using Table C.
i. Step 13: Determine the activity value.
j. Step 14 involves assessing the level of work posture risk based on the criteria defined. These criteria include five categories: a score of 1 indicates negligible risk, scores of 2–3 indicate low risk, scores of 4–7 indicate medium risk, scores of 8–10 indicate high risk, and scores of 10–15 indicate very high risk.

Anthropometric in Design

Anthropometry is frequently used by ergonomics experts in designing systems intended for human use. This design must consider human body dimensions to create appropriate space and products(Wijaya et al., 2024). Anthropometry is a crucial aspect of ergonomics, especially in designing tools and equipment that are comfortable and safe. More specifically, anthropometry involves numerical data related to human body characteristics, including size, shape, and strength, and the application of this data in solving design problems(Rega et al., 2024). The application of anthropometry relies on the mean value and standard deviation within a normal distribution, which has both mean and standard deviation values

Standart deviasion formula: $\sigma = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}}$ (1)

Where:
σ : standart deviasion
$\bar{x}$: mean
x_i : i-th data point
n : number of data points

Mean formula: $\bar{x} = \frac{\Sigma x}{n}$ (2)

$\bar{x}$: mean
Σx : sum of data points
n : number of data points

Tabel 1. Percentile Calculation Formula

Persentil	Formula
5th	$\bar{x} - 1.64\sigma$
10th	$\bar{x} - 1.28\sigma$
50th	$\bar{x}$
90th	$\bar{x} + 1.28\sigma$
95th	$\bar{x} + 1.64$

3. RESULTS

This study uses the REBA method to analyze work posture. This method evaluates body posture, load, and muscle activity, providing a score to determine the risk level of MSDs. The score helps identify improvement priorities and assess the effectiveness of ergonomic actions(Sugiono et al., 2024). REBA aims to identify risk factors that affect the overall body condition. With this method, the safety level of workers' postures can be assessed. The assessment is carried out using a REBA worksheet to determine the final score, applied when workers perform grinding activities(Kee, 2022).

Figure 1. Posture of the Grinding Worker 1

Tabel 2. Calculation of the REBA Score of Grinding Posture1

No	Factor	Movement	Adjust	Score
		Group A Posture		
1	Locate neck position	Forms an angle > 20°		2
2	Locate trunk position	Forms an angle between 20°-60° and the trunk bends	1	3 + 1 = 4
3	Locate legs position	Both legs support body weight and bend forming an angle > 60°	2	1 + 2 = 3
4		Look-up posture score in table A		7
5	Add force/load score	< 11 lbs		0
6	Score A, find row in table C			7
		Group B posture		
7	Locate upper arm position	Forms an angle between 20°-45° and the arm bends	1	2 + 1 = 3
8	Locate lower arm position	Positioned between angles 60°-100°		1
9	Locate wrist position	Forms an angle > 15° and the wrist	1	2 + 1 = 3
10		Look-up posture score in table B		5
11	Add coupling score	Well-fitting handle and mid-range power grip		0
12	Score B, find column in table C			8
13	Step 13: activity score	Static work		1
		REBA score		**9**

The assessment of grinding posture 1 resulted in a REBA score of 9, indicating a high risk to workers' health and safety. This score suggests a non-ergonomic posture that could lead to muscle strain or *musculoskeletal disorders*.

Tabel 3. Anthropometric Data of Grinding Workers

Respodent	TSD Dimension	PTD Dimension	TPO Dimension
1	29	73	43
2	27	71	41
3	27	71	41
4	26.5	70	40
5	27.5	71.5	41.5

a. Table Height Calculation

To determine the table height, anthropometric data for seated elbow height (TSB) and popliteal height (TPO) at the 50th percentile is used. The table height is calculated by adding the seated elbow height (TSB) and popliteal height (TPO) as follows:

$$\bar{x}\ \text{TSD} = \frac{29 + 27 + 27 + 26{,}5 + 27{,}5}{5} = 27{,}4\ \text{cm}$$

$$\bar{x}\ \text{TPO} = \frac{43 + 41 + 41 + 40 + 41.5}{5} = 41{,}3\ \text{cm}$$

50th percentile = $\bar{x}$

Table height = TSB + TPO = 27.4 + 41.3 = 68.7 cm

The calculation shows that the ideal table height is 68.7 cm, based on the 50th percentile anthropometric data.

b. Table Length Calculation

The table length is determined using the PTD anthropometric data with the 5th percentile. Using the smallest size, the tool is designed to fit the worker's posture, enhancing comfort and ergonomics.

$$\bar{x}\ \text{PTD} = \frac{73 + 71 + 71 + 70 + 71{,}5}{5} = 71{,}3\ \text{cm}$$

$$\sigma\ \text{PTD} = \sqrt{\frac{(73-71{,}3)^2+(71-71{,}3)^2+(71-71{,}3)^2+(70-71{,}3)^2+(71{,}5-71{,}3)^2}{5-1}} = 1{,}0954$$

5th percentile = $\bar{x}$ – 1,645 x σ

= 71,3 – 1,645 x 1,0954

= 69,49

The calculation shows the forward arm length at the 5th percentile is 69.49 cm, rounded to 69.5 cm. This will be the table length dimension.

c. Table Width Calculation

The table width is determined based on the worker's elbow span to meet ergonomic standards, improve work efficiency, comfort, and reduce fatigue or injury risk during grinding. The ideal table width is 80 cm to ensure optimal working posture and support productivity.

d. Chair Height Calculation

The chair height is calculated using the TPO anthropometric data at the 50th percentile. With this average size, the tool can be designed to match the worker's posture, improving comfort and ergonomics during grinding.

$$\bar{x}\ \text{TPO} = \frac{43 + 41 + 41 + 40 + 41.5}{5} = 41{,}3\ \text{cm}$$

50th percentile = $\bar{x}$

The calculation shows that the 50th percentile popliteal height is 41.3 cm, which will be used as the chair height dimension.

e. Chair Length and Width Calculation

The chair length and width are adjusted to match the existing chair size at PT Kanugrahan Techno Engineering, which is 25 cm.

The grinding process is performed while sitting or squatting, which may affect the operator's comfort. After the design concept is completed, the next step is to design the physical shape of the product according to user needs and preferences.

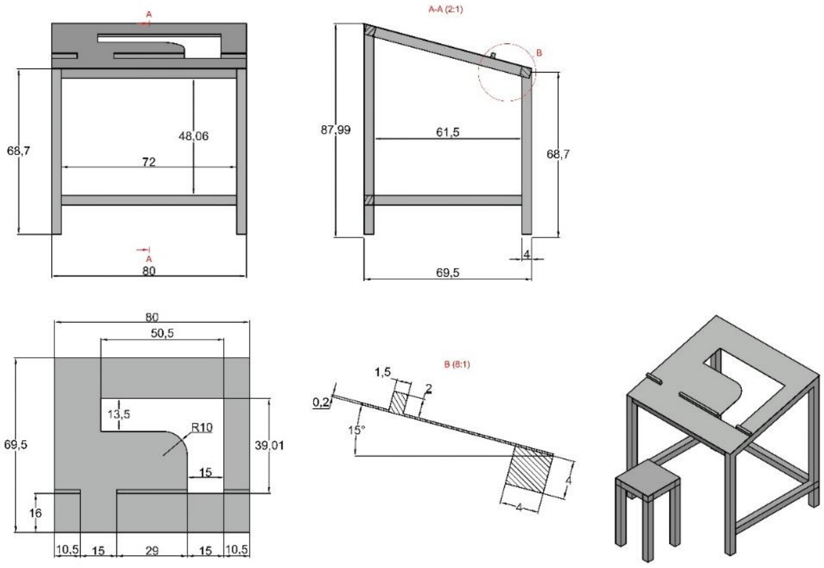

Figure 2. Technical Drawing of the Grinding Assistance Table

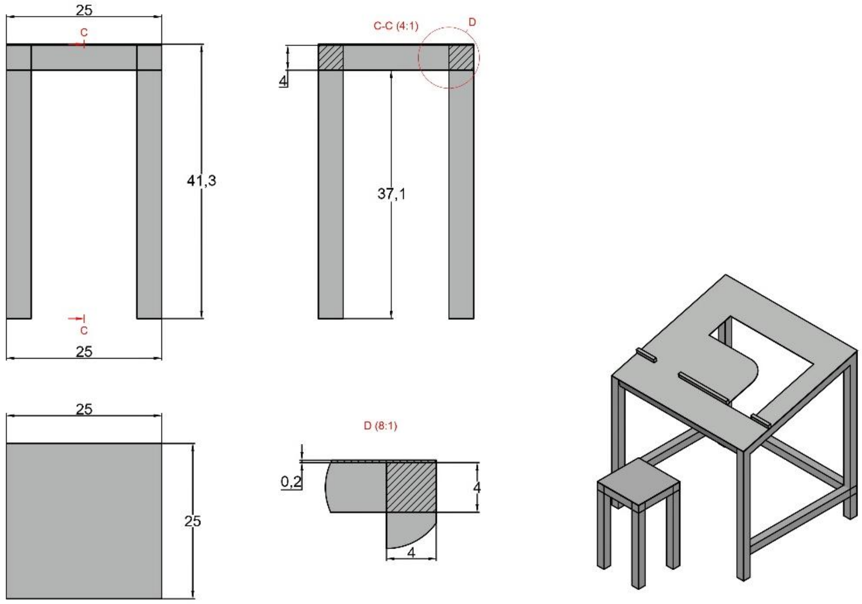

Figure 3. Technical Drawing of the Grinding Assistance Chair

4. DISCUSSION

Among the five grinding postures assessed using the REBA method, grinding posture 1, used as a sample, and posture 2 both scored 9, indicating very high risk and requiring immediate action. Grinding posture 3 scored 10, reflecting an extremely high risk that needs serious attention. Meanwhile, grinding postures 4 and 5 scored 7, indicating moderate risk that can still be improved with simple measures. Therefore, a grinding aid is being designed to mitigate these risks.

Based on the collected data, the TSD, PTD, and TPO dimensions can be used as references to design the grinding table and chair assistive tools. These tools are designed to ensure worker comfort during grinding, maintaining physical well-being. This grinding assistance tool is designed to reduce the risk of *musculoskeletal disorders* (MSDs) with an ergonomic design. The table is made from galvanised hollow legs and a steel plate, while the chair is made from the same material, with a height of 44 cm and a 25 x 25 cm base. The table has an opening for easier work.

Operation starts by ensuring the table and chair are on a level surface. The grinding tool is mounted on the table, and the worker sits with their feet on the floor, keeping their body straight and shoulders relaxed. The material is placed on the table, and grinding is done slowly while holding the material steady with both hands. Workers are advised to take 5–10 minute breaks every 30–60 minutes.

The production cost for the chair is Rp 215,878, and the table is Rp 495,088, making the total cost for one set Rp 710,966. For 5 sets, the total cost is Rp 3,554,833.91. This tool improves comfort, efficiency, and reduces health risks for workers.

5. CONCLUSION

This study analyzes the risk of *musculoskeletal disorders* (MSDs) experienced by workers during grinding activities at PT Kanugrahan Techno Engineering using the REBA method. The results show that grinding activities 1 and 2 have a REBA score of 9, indicating very high risk and requiring immediate improvement. Grinding activity 3 has the highest score of 10, indicating extreme risk and needing more serious attention. Grinding activities 4 and 5 have a score of 7, which indicates moderate risk and can be improved through posture adjustment or the use of ergonomic aids. The results emphasize the need for improvements in all grinding stages, especially in activity 3 with the highest risk.

To mitigate the risks, ergonomic aids such as a table and chair were designed, with the cost for one set being Rp 710.966. For 5 tables and 5 chairs, the total cost is Rp 3.554.833,91. These aids are expected to improve comfort, reduce injury risks, and increase work productivity.

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