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Risk Analysis of Musculoskeletal Disorders (MSDs) of The Material Handling Process in Waste Processing Operators Using The Rapid Whole Body Assessment Method

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Abstract: Businesses should never stop trying to include every employee in their operations and never skimp on safety precautions. One of the safety methods in the worker-centered approach implementation is the significance of ergonomics. Typically, material handling phases in production processes include physical labor that demands a lot of operator effort. Handling objects by hand raises the possibility of workplace mishaps, which can lead to musculoskeletal injuries. This study focuses on the different labor postures used for gathering, transferring, and positioning waste as well as the manual handling of waste items up to the shredding area. This study evaluates work postures that may result in symptoms of musculoskeletal diseases using the Rapid Entire Body Assessment (REBA) technique. There are three steps in this process. Prior to lowering the waste bucket to the designated place, gather the trash first, then hoist and carry it till it reaches the mechanical area. Three grades 9, 2, and 6 were obtained from the analysis utilizing the REBA (Rapid Entire Body Assessment) approach. Based on these findings, the first stage has to be improved right away. Thus, in order to meet the improvement objective, we created a telescopic reach that enables employees to change the height a device that aids in bettering workers' posture while picking up trash.

Keywords: Material handling; Ergonomic worker-centered approach; Rapid Entire Body Assessment (REBA); Telescopic device

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1. Introduction

Where safety procedures cannot be disregarded, businesses must make constant efforts to involve every employee in the process [1]. Numerous studies have demonstrated the value of ergonomics in the context of putting a worker-centered approach into practice. Production procedures typically involve manual material handling steps that demand a lot of the operator's energy. Manual material handling activities include lifting, pushing, shouldering, carrying, tugging, and other tasks that do not require the use of assistive devices [2]. Musculoskeletal disorders are among the occupational injuries that manual material handling poses a high risk of [3].

Given that various muscle types are involved in different work postures, one occupational disease brought on by poor posture is musculoskeletal system [4]. This study focuses on the method of manual material handling used in the Design and Development Laboratory, Mechanical Engineering Department, for gathering, transporting, and positioning waste materials up to the waste shredding machine area. Repetitive transfers may result in injuries to the officers [5]. Poor postures and working positions are the result of

material handling at a relatively high repetition level [6]. To reduce the risk of occupational injuries, it is imperative to measure work postures that facilitate the onset of symptoms of Musculoskeletar Disorder, particularly for officers responsible for collecting waste for composting. The work postures that define the movement of body parts will be analyzed in this study using the REBA (Rapid Entie Body Assessment) Method [7]. Moreover, the study's findings will serve as the foundation for the creation of instruments that reduce worker injuries related to waste material handling.

2. Materials and Experiment Methods

This study is an experimental research with a case study model. The research was carried out at the Jakarta State Polytechnic campus regarding the production process of waste treatment machines at the Design and Development Laboratory of the Department of Mechanical Engineering. An in-depth analysis of a single case utilizes the Rapid Entire Body Assessment (REBA) method—research support equipment in waste buckets, scales, rulers, and meters. In addition, AutoCAD software is used to assess workers' posture. The Rapid entire-body assessment method is one of the ergonomic methods used to assess the posture of the operator's neck, back, arms, wrists, and legs [8]. This method is considered very relevant to the problems faced by small and medium enterprises. The REBA method is influenced by aspects of external forces acting on objects and work activities [9].

Evaluation with the REBA method does not take too much time and provides a general assessment of the list of activities that demonstrate the need to reduce the risks posed by the operator's work behavior. The data was taken by documenting one of the operators. The test results will be processed in the form of a table referring to the REBA Employee Assessment Worksheet as shown in Figure 1. The flow of the research process is shown as shown in Figure 2.

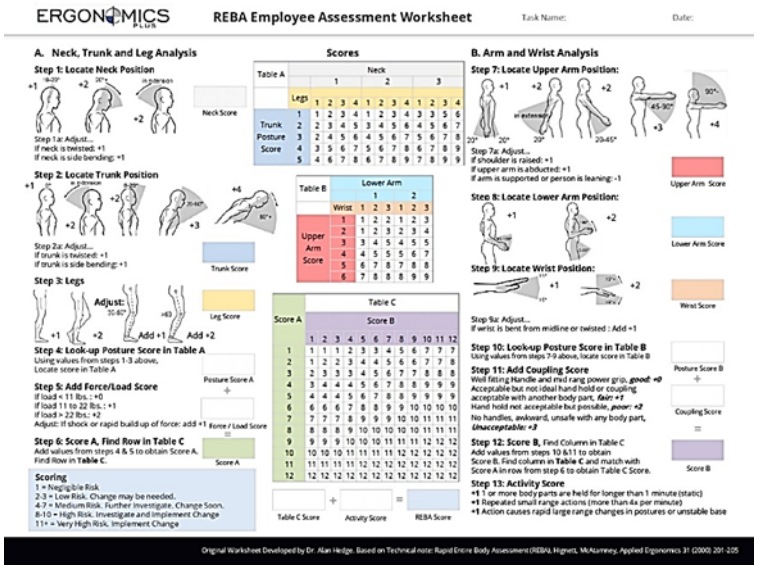

Figure 1. Worksheet Assessment REBA [10]

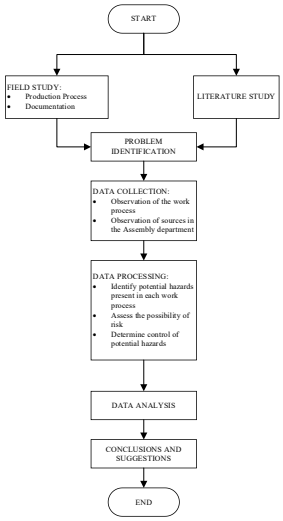

Figure 2. Research Flow Process

Following the completion of all equipment preparation, data collection began with recording workers handling waste materials to be processed in three stages: collecting waste in buckets, lifting buckets to storage locations, and lowering buckets.

The first step in the Rapid Entire Body Assessment method is posture assessment, which is divided into two sections. The back/body, legs, and neck make up Part A. The upper arm (shoulder), forearm (elbow), and wrist make up Part B [11]. When the waste bucket lifting process is underway, each component will be assigned a value based on the work posture. The outcomes will be contrasted with the REBA action level, as indicated in Table 1.

Table 1. REBA Action Level

Total Nilai	Risk Level	Corrective Action
1	Neglected	Not necessary
2-3	Low	Might Be Necessary
4-7	Medium	Needed
8-10	High	Needed As Soon As Possibly
11-15	Very High	Required Now

3. Results and Discussion

The assessment is conducted using the Rapid Entire Body Assesment (REBA) method to determine whether the work posture is within a safe level or not. The findings of the study are explained as follows:

3.1 Initial data collection at first step

Gathering preliminary data from the waste retrieval step. Table 2 displays the findings from the first stage of the Rapid Entire Body Assessment (REBA) method.

Table 2. Waste Retrieval Step

Num.	Picture	Body Part					
		Neck	Back	Feet	Upper arm	Forearm	Wrist
1		A 41˚ position angle	A 59˚ position angle	A 145˚ position angle	A 65˚ position angle	A 100˚ position angle	A 19˚ position angle
Score		3	3	2	3	2	2

Furthermore, the calculation of scores according to the Rapid Entire Body Assesment (REBA) method which refers to figures 3, 4 and 5.

a. Score A

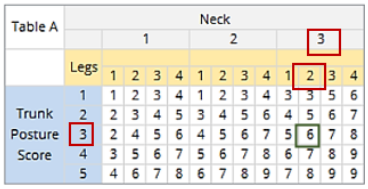

Figure 3. A1 score in REBA Worksheet

A score of 6 is obtained based on the results referring to the Rapid Entire Body Assesment (REBA) worksheet; the score does not increase because workers carry loads weighing less than 11 lbs (4.9 kg).

b. Score B

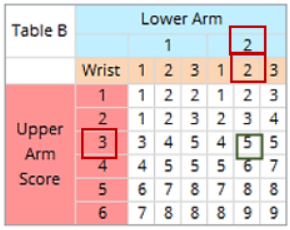

Figure 4. B1 score in REBA Worksheet

According to the findings using the Rapid Entire Body Assessment (REBA) worksheet, a score of 5 is obtained based on the results referring to the Rapid Entire Body Assesment (REBA) worksheet; the score does not increase because workers carry loads weighing less than 11 lbs (4.9 kg).

c. Score C

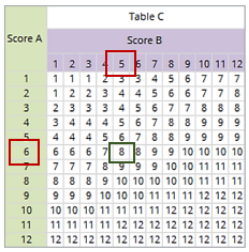

Figure 5. Total Score Step 1

According to the Rapid Entire Body Assessment (REBA) worksheet, the overall score was 8. However, because workers perform repetitive work movements, there is an additional value of 1, which adds up to a C score of 9.

3.2 Initial data collection at second step

Gathering preliminary data from the stage of bucket lifting to storage point. Table 3 displays the findings from the second stage of the Rapid Entire Body Assessment (REBA) method.

Table 3. Bucket Lifting

Num.	Picture	Body Part					
		Neck	Back	Feet	Upper arm	Forearm	Wrist
1		A 16˚ position angle	A 14˚ position angle	Standing leg with balanced weight	Position angle parallel to the shoulder	A 57˚ position angle	A 19˚ position angle
Score		3	1	3	1	1	2

Furthermore, the calculation of scores according to the Rapid Entire Body Assesment (REBA) method which refers to figures 6, 7 and 8.

a. Score A

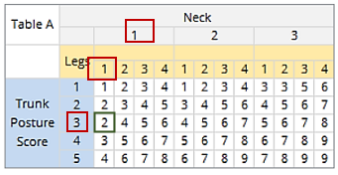

Figure 6. A2 score in REBA Worksheet

A score of 2 is obtained based on the results referring to the Rapid Entire Body Assesment (REBA) worksheet; the score does not increase because workers carry loads weighing less than 11 lbs (4.9 kg).

b. Score B

Table B		Lower Arm					
		1			2		
	Wrist	1	2	3	1	2	3
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Figure 7. B2 score in REBA Worksheet

According to the findings using the Rapid Entire Body Assessment (REBA) worksheet, a score of 1 is obtained based on the results referring to the Rapid Entire Body Assesment (REBA) worksheet; the score does not increase because workers carry loads weighing less than 11 lbs (4.9 kg).

c. Score C

Score A	Table C										
	Score B										
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Figure 8. Total Score Step 2

According to the Rapid Entire Body Assessment (REBA) worksheet, the overall score was 1. However, because workers perform repetitive work movements, there is an additional value of 1, which adds up to a C score of 2.

3.3 Initial data collection at third step

Gathering preliminary data from the stage of bucket placement. Table 4 displays the findings from the third stage of the Rapid Entire Body Assessment (REBA) method.

Table 4. Bucket Placement

Num.	Picture	Body Part					
		Neck	Back	Feet	Upper arm	Forearm	Wrist
1		A 32˚ position angle	A 60˚ position angle	Standing leg with balanced weight	A 89˚ position angle	A 30˚ position angle	A 19˚ position angle
Score		3	2	3	2	3	2

Furthermore, the calculation of scores according to the Rapid Entire Body Assesment (REBA) method which refers to figures 9, 10 and 11.

a. Score A

Table A		Neck									
		1				2			3		
	Legs	1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Figure 9. A3 score in REBA Worksheet

A score of 5 is obtained based on the results referring to the Rapid Entire Body Assesment (REBA) worksheet; the score does not increase because workers carry loads weighing less than 11 lbs (4.9 kg).

b. Score B

Table B		Lower Arm					
		1			2		
	Wrist	1	2	3	1	2	3
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Figure 10. B3 score in REBA Worksheet

According to the findings using the Rapid Entire Body Assessment (REBA) worksheet, a score of 4 is obtained based on the results referring to the Rapid Entire Body Assesment (REBA) worksheet; the score does not increase because workers carry loads weighing less than 11 lbs (4.9 kg).

c. Score C

Score A	Table C											
	Score B											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Figure 11. Total Score Step 3

According to the Rapid Entire Body Assessment (REBA) worksheet, the overall score was 5. However, because workers perform repetitive work movements, there is an additional value of 1, which adds up to a C score of 6.

In Table 5 provides a summary of the evaluation of the three steps in the overall REBA score process.

Table 5. REBA Total Score in Each Step

Total of REBA Score			
Total Skor *Rapid Entire Body Assesment*	Waste Retrieval	9	High Risk, Needed As Soon As Possibly
	Bucket Lifting	2	Low Risk, Might be Necessary
	Bucket Placement	6	Medium Risk, Needed

Based on the findings of the aforementioned study, corrective action must be made, particularly during the waste collection stage, which carries a high risk of accidents due to its high value. Therefore, workers can use the required waste pickers and lifters as material handling aids in an effort to reduce risk. The tool design outcomes are illustrated in Figures 12 and 13.

Figure 12. Design of additional tool

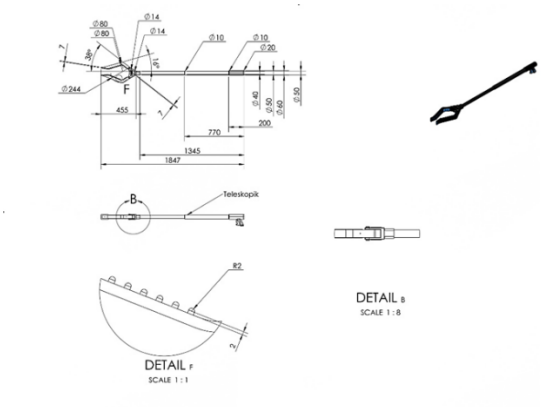

Figure 13. Drawing of additional tool

The grabber reacher's unique design allows workers to remove waste without bending over. The tool's height can be adjusted to match the distance between the worker's hand and the ground. Grabber reaches are made especially for collecting waste, such as tiny, dry leaves and stems.

4. Conclusions

Several conclusions were drawn from the outcomes of studies conducted on the analysis of worker postures that facilitate the onset of symptoms of Musculoskeletal Disorder using the Rapid Entire Body Assessment (REBA) method. Three categories are used to evaluate workers in the waste collection process: those involved in the collection, transportation, and placement of waste products up until the point where the waste shredding machine is located. The three processes' workers' postures produced REBA scores of 2, 6, and 9. With a score of 9, the collection process produced the best results, necessitating quick improvement to reduce risks that lead to occupational injuries. 2. Utilizing instruments made specifically for gathering waste, such as tiny, dry leaves and stems, can help reduce the frequency of Musculoskeletal Disorder symptoms during the waste collection process.

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