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Analysis of Work Posture in Steelmaking Drilling Section Using RULA and REBA Methods at PT. Ravana Jaya

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ABSTRACT

PT. Ravana Jaya is a general contractor working on steel fabrication and has several partners from small, medium, and large scale companies. Observations showed that workers reported complaints related to pain in several parts of the body in the upper neck, lower neck, back, and left and right shoulders with a percentage value of 85% in the location of pain complaints in the upper neck area. This research uses the RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment) methods. The results of the RULA and REBA scores in the punching process are 7 and 9 with a high risk category so that it is necessary to hold a work posture improvement solution by adjusting the height of the workstation and using an adjustable bench, using ergonomic tools such as drilling machines and material support tools to reduce physical loads, job rotation and regular breaks to prevent muscle fatigue. These improvements are not only beneficial for the health and well-being of workers, but also for the sustainability of company operations.

INTRODUCTION

PT Ravana Jaya is a company operating in the field of steel construction with an outsourcing system, which relies on steel as the main raw material. The iron production process goes through several processes, including Marking, Cutting, Grinding, Drilling, Assembling, Welding, Sandblasting, and Painting. The problem found by the author is that most of the work is done by relying on human labor, which risks causing excessive fatigue for workers. Based on initial observations, workers reported complaints related to pain or stiffness in several parts of the body, especially in the upper neck, lower neck, back, and left and right shoulders. The explanation of the above problems indicates that most workers experience complaints in the neck, back, and shoulders. These areas of the body are prone to musculoskeletal disorders, especially due to unergonomic work postures, which often force workers to maintain poor body positions for long periods of time. These complaints need attention to identify the cause and prevent long-term health problems for workers.

Research on work posture analysis has a very important role in various fields, especially those related to health, safety, and worker productivity (Marcaesa, 2021). Unergonomic work postures can cause musculoskeletal injuries or disorders, such as back, neck, shoulder and wrist pain (Arifin Y. L., 2019). By conducting this research, we can identify risky postures and provide recommendations to reduce the negative impact, thus helping to prevent long-term injuries. In addition, good work postures can also improve worker efficiency and comfort, which in turn leads to increased productivity (Kurnia, 2020). This research helps find ways to optimize the work environment so that workers can complete tasks more quickly and effectively. Not only

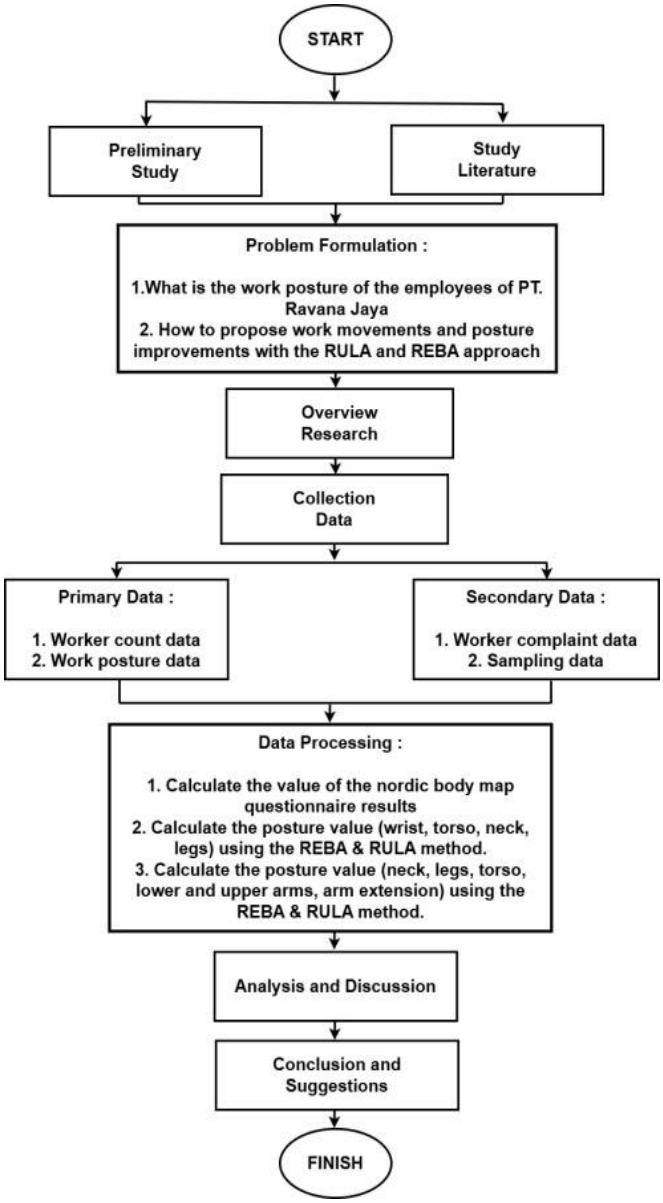
that, research on work posture analysis can also reduce health and compensation costs for companies (Wahyuniardi, 2018). Injuries due to poor work posture can lead to high medical and workers' compensation costs. By conducting work posture analysis, companies can reduce these costs by preventing injuries before they occur (Valensiana, 2024). In addition, ergonomic work postures can also improve workers' quality of life, not only in terms of physical health but also mental and emotional well-being. This study can also reduce turnover and absenteeism (Sari, 2020). Companies can reduce these problems and maintain a healthy and productive workforce by improving work postures. Finally, research on work posture analysis is helpful in the development of ergonomics science and best practices in the workplace (Yuliani, 2020). This research can be used as a reference for broader research and policy implementation (Hunusalela, 2022). Therefore, research using work posture analysis benefits companies, industries, and society as a whole, not just individual workers. It is a long-term investment to improve safety, health, and productivity in the workplace (Wandiyanto, 2022).

In solving the above problems, the most objective methods are RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment), used to assess and analyze upper body posture. These methods serve to examine the relationship between posture, muscle use, and worker movement, and evaluate the risk of injury associated with work activities. The purpose of this study is to provide a clear understanding of the work postures applied by workers at PT Ravana Jaya, so that it can be seen to what extent these postures meet good ergonomic standards and provide information on the risk value of upper body postures that are at risk of injury which can help in ergonomics and work safety assessments by implementing several proposed improvements to these work postures.

RESEARCH METHODS

Research Scenario

The first step in this research process is data collection, in the data collection process is carried out to obtain the required data, the subject in this study is workers who carry out activities manually in the steel making drilling process. Data collection by observing the activities of workers during the drilling process, researchers took photos of worker activities with a cellphone camera and to find out the angle of the work activity photos the researcher used the angle meter 360 application, and for data processing after all angles were known the researcher used a software tool called ergofellow. The more detailed steps in the research process are as follows.



Picture 1 Research Process Flowchart

RULA (Rapid Upper Limb Assesment)

Dr. Lynn Makatamney and Dr. Nigel Coalette from the University of Nottingham (Institute of Occupational Ergonomics) developed the RULA (Rapid Upper Limb Assessment) method. This method is used to evaluate upper body posture in the context of ergonomics, specifically to assess and assess upper extremity posture (Anggraini, 2022). RULA is used to identify possible injuries caused by repetitive strain and assess the posture, strength, and muscle activity involved during work (Ariyo, 2022). The RULA method takes a short period of time and is performed with a list of activities performed to demonstrate that there is a need for risk reduction through physical lifting of the operator (Malik, 2021). The RULA method can be used to evaluate and identify musculoskeletal risks that can occur while working without requiring a long time for assessment, as the assessment results are based on a risk scale of 1 to 7, where a value of 7 indicates the highest level of risk that can cause serious injury (Erliana, 2021).

REBA (Rapid Entry Body Assesment)

To evaluate the operator's working posture, which includes the back, arms, wrists, and legs, the science of ergonomics, the REBA method is used. The REBA method has advantages,

such as a decision level that can show how important the action to be taken is (Pratiwi, 2021). REBA is a methodical method that evaluates a worker's full-body posture to determine whether or not they are at risk for MSDs and other risks associated with their job (Faudy, 2022). REBA does not require a lot of expertise or expensive equipment to use as it is made to be easy to use (Larasati, 2022). REBA sheets and stationery are the only things required. The REBA method examines overall ergonomic risk factors on the body in use. These factors include dynamic or static postures, changes in posture or unstable postures, lifting being performed, and odification of the place (Dewantari, 2021).

Nordic Body Map

An important step to determine the cause of musculoskeletal disorders is to determine ergonomic measures (Dewanti, 2024). A tool called the Nordic Body Map (NBM) can be used to identify areas of the body that experience discomfort, ranging from mild pain to very severe pain (Valensiana, 2024). This body map helps us understand how human muscles move and work. It also helps us understand the areas of the body that are affected by disorders of the musculoskeletal system (Khoirunnisa, 2024). The calculation formula for respondents experiencing complaints in certain parts of the body is :

$$\text{Average Score} = \frac{Sum\ of\ Individual\ Scores}{\text{Total Number of Respondents}} \quad (1)$$

$$\text{Percentage of Complaints} = \frac{Number\ of\ Responses\ of\ Relevant\ Weight}{\text{Total Number of Respondents}} \quad (2)$$

RESULTS AND DISCUSSION

Nordic Body Map

In the questionnaire, questions included health problems experienced by workers, such as complaints of pain, soreness, and aches. During work, some workers are known to have less ergonomic work postures, which can trigger pain, fatigue, and muscle damage. muscleThe following is a recap of the questionnaire data, where for clarity, the level of pain is given the following description: Number 1: No pain, Number 2: Slight pain, Number 3: Pain, Number 4: Severe pain. The table below shows the results of the total score of workers in each area where they work, showing the level of risk for each body part they complain about.

Table 1 Results of Questionnaire Data Recapitulation

Work Station	Workers	Score	Risk Level
Drilling / punching process using drill tools	Worker 1	84	High
	Worker 2	78	High
	Worker 3	73	High
	Worker 4	68	Medium
	Worker 5	62	Medium
	Worker 6	63	Medium
	Worker 7	78	High
	Worker 8	70	Medium
	Worker 9	74	High
	Worker 10	66	Medium

Source: Questionnaire Filling Production Operator PT.Ravana Jaya

Based on the table above, in two work activities carried out at PT Ravana Jaya, different levels of risk levels were obtained from 10 workers. From these results, it was found that 5 workers experienced complaints with a high risk level, 5 workers experienced complaints with a moderate risk level. The following is a frequency distribution table showing the results of the Nordic Body Map (NBM) questionnaire recap based on the level of risk experienced by workers at PT Ravana Jaya.

Table 2 Risk Level Score

Risk Level	Number of Workers	Percentage
Low Risk (Blue)	0	0 %
Medium Risk (Green)	5	50 %
High Risk (Yellow)	5	50 %
Very High Risk (Red)	0	0 %

Rappid Upper Limb Assesment (RULA)

The RULA data collected through documentation, photographs, and direct observation shows the field conditions in the work environment of PT Ravana Jaya. Once the data is collected, the worker's posture is assessed on each relevant body part. This is done by calculating the value based on the angle of the posture seen when the worker is performing the activity.

Picture 2 Punching Process Using Drilling Tools
Source: PT Ravana Jaya

Assessment of posture in the punching process for group A in the upper arm position, the angle formed is 108° so that the score given is 4, for the lower arm position, the angle formed is 162° so that the score obtained is 2, the angle of the wrist that is more than 15° is given a score of 3, in the wrist rotation section, a score of 1 is given.

Table 3 Wrist, Upper and Lower Arm Posture Scores

Score									
Table A Wrist Posture Score									
		1		2		3		4	
Upper Arm	Lower Arm	Whish Twish		Whish Twish		Whish Twish		Whish Twish	
		1	2	1	2	1	2	1	2
	1	1	2	2	2	2	3	3	3
1	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
	1	2	3	3	3	3	4	4	4
2	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5

	2	3	4	4	4	4	5	5
	3	4	4	4	4	5	5	5
	1	4	4	4	4	5	5	5
4	2	4	4	4	4	5	5	5
	3	4	4	4	5	5	6	6
	1	5	5	5	5	6	6	7
5	2	5	6	6	6	7	7	7
	3	6	6	6	7	7	7	8
	1	7	7	7	7	8	8	9
6	2	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9

Source: RULA Method Data Processing

Wrist & forearm values
= Posture Value A + Muscle Value + Load = 4 + 1 + 0 (because the load is less than 4.4 lbs) = 5

Assessment of posture in the punching process for the attitude of group B, the neck angle is 32° so that the score given is 3, in the back posture, the back side forms an angle of 104° so that the score given is 4, the position of the legs is bent, so the score given is 2.

Table 4 Score Torso, Neck, Legs

Neck Posture Score	Table B: Torso Posture Score											
	1		2		3		4		5		6	
	Legs		Legs		Legs		Legs		Legs		Legs	
	1	2	1	2	1	2	1	2	1	2	1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Source: RULA Method Data Processing

Neck, torso and leg values
= Posture Value B +Muscle Value + Load
= 6 + 1 (stastic posture > 10 minutes & reps) + 0 (because the load is less than 4.4 lbs) = 5

After the results of group A and group B are known, the stage of determining the grand total score is continued. The grand total score value is found using the table below.

Table 5 Neck, Torso, Leg, Wrist Scores

Table C		Neck, Torso, Legs Score						
		1	2	3	4	5	6	7+
Wrist/Arm Score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

Source: RULA Method Data Processing

The final score for the operator's process activity of punching holes with a drilling tool (Drilling process) is 7. As a result of the score, the risk level of the pattern making and cutting

process falls into the risk level for the "High" category and action is needed to improve work attitude in the future.

Rappid Entire Body Assesment (REBA)

REBA data processing refers to the posture angle seen when workers perform activities as shown in Figure (1). Posture assessment in the punching process for group A attitudes in the neck position the angle formed is 38 ° so that the score given is 2, for the position of the torso the angle formed is 115 ° so that the score obtained is 4, for the position of the legs the angle formed is 32 ° with the position of the legs bending so that the score given is 3.

Table 6 Neck, Legs, and Torso Score

Table A		Neck											
	Legs	1				2				3			
		1	2	3	4	1	2	3	4	1	2	3	4
Score Trunk Body	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

Source: REBA Method Data Processing

Neck, legs and torso values
= Table value A + Load = 7 + 0 (because the load is less than 4.4 lbs) = 7

Assessment of posture in the punching process for group B in the position of the upper arm the angle formed is 20 ° so that the score given is 2, for the position of the forearm the angle formed is 75 ° so that the score obtained is 1, for the position of the wrist the angle formed is 24 ° so that the score given is 2.

Table 7 Lower Arm, Wrist, Upper Arm Scores

Table B		Lower Arm					
	Wrist	1			2		
	Hand	1	2	3	1	2	3
Score Arms Upper	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

Source: REBA Method Data Processing

Value of forearm, upper arm, wrist
= Table value B + Load = 2 + 0 = 2

Based on the calculation of the value of table B summed with the loading, it can be seen that the value of table B is 2. The next step is to calculate the value of table C.

Table 8 Score A and B, Table 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	10	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

Source: REBA Method Data Processing

Based on the table above, it can be seen that the A score obtained is 7 and the B score is 2 and the C group score is 7. The next step is to determine the value of the activities experienced by workers in the punching process.

REBA score = C score + activity score
= 7 + 2 = 9

Table 9 REBA Result Score

Score	Risk
1	Negligible risk
2 or 3	Low risk, changes may be required
4 to 7	Medium risk, further investigation, change immediately
8 to 10	High risk, investigate and implement changes
11 and so on	Very high risk, implement changes

Source: Ergofellow Software Data Processing Results

Based on the table above, the REBA score at the punching station obtained a score of 9, which means it is in the high category so it needs immediate improvement.

Interpretation and Comparison of Previous Research Results

The results of the Nordic Body Map questionnaire show that 50% of employees have a high risk and 50% moderate risk of musculoskeletal complaints, with the main complaints in the upper and lower neck, back, and left and right shoulders, indicating that workers experience discomfort and risk of injury due to non-ergonomic work postures and repetitive activities during the punching process. To reduce the risk of long-term injury, immediate ergonomic intervention is required. In the punching process, the RULA score of 7 falls into the high-risk category, indicating an unergonomic working posture, especially in the upper arm, forearm and wrist. This finding is in line with the Nordic Body Map results that identified problems in the neck, back and shoulders. The high RULA score suggests the need for work posture improvements, such as raising the work table and using ergonomic aids. In addition, the REBA score of 9 also falls into the high-risk category, indicating hazardous work postures of the neck, torso, and legs. The Nordic Body Map, RULA, and REBA results are consistent in showing the high discomfort and risk of injury experienced by employees. The high REBA score emphasized the need for immediate improvements, such as worktable height adjustment, use of assistive devices, and job rotation, to reduce workload and prevent musculoskeletal injuries.

The results of Arifin's (2019) study assessing physical workload with the RULA and REBA methods at PT Agility International are also similar to the results of this study (score 7). The study also found high RULA scores (scores of 6-7) in workers performing repetitive activities such as lifting and moving materials, suggesting that jobs involving repetitive movements and unergonomic postures tend to have high RULA scores. In this study, the REBA score (score 9) is in line with the findings of Sari (2020), who assessed the risk level of workers at the header pipe work point using REBA and RULA methods. The study also found that workers who performed activities involving unergonomic postures, such as bending and lifting, received high REBA

scores (scores of 8-10), indicating that poor working postures and repetitive activities are factors that contribute to the level of risk.

Improvement Solution

The tools used to assess ergonomic risks and postures that can potentially cause musculoskeletal injuries, especially when performing activities such as drilling, are REBA and RULA. Unergonomic behaviors, such as bending, twisting the body, or raising the arms in an uncomfortable position, often occur during the drilling process. To reduce these risks, there are several improvements that can be made. First, the operator's working posture should be improved by changing the height of the workstation and using an adjustable bench to remain neutral while working. The material to be punched should be placed in a position that is easy to reach, not too low or too high. The use of tools such as material supports and ergonomic drilling machines can also help reduce the burden on the operator's body. To prevent muscle fatigue due to repetitive motion, rotate jobs and take regular breaks. Operators should be trained on safe working postures and ergonomics to reduce injuries. The work environment also needs to be considered, such as adequate lighting and the use of anti-fatigue flooring if the operator has to stand for a long time. After implementing this solution, reassessment with REBA and RULA needs to be done to ensure the work posture has improved, as well as periodically monitoring the operator's health. With these measures, the risk of musculoskeletal injuries can be reduced, and operator comfort and productivity can be increased.

CONCLUSIONS

Based on the results of the Nordic Body Map, the percentage of risk levels with a total of 10 workers is a ratio of 50% high and 50% medium categories with the highest risk level score of 84 and for a medium risk score of 62. For RULA and REBA scores, values of 7 and 9 were obtained, including high categories. The implications of these findings include serious impacts on worker health, such as fatigue, muscle pain, and musculoskeletal injuries, which can reduce productivity and increase company health costs. A high risk of injury can also lead to absenteeism, reduced work quality, and increased operational costs. Besides.

The recommendations can be implemented by the company such as improving work posture by adjusting workstation height and using adjustable benches, using ergonomic tools such as drilling machines and material support tools to reduce physical loads, job rotation and regular breaks to prevent muscle fatigue, ergonomics training on safe work postures and ergonomics awareness for workers, improving the work environment with adequate lighting and anti-fatigue flooring, periodic monitoring and evaluation. By implementing these recommendations, the risk of musculoskeletal injuries can be reduced, work comfort increased, and worker productivity can be maintained or improved.

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