International journal of science, engineering, and information technology
Volume 08, Issue 01, December 2023
Journal homepage: https://journal.trunojoyo.ac.id/ijseit

Evaluation of Improving Working Posture Using the Rula and Reba Method in the 3 Kg LPG Cylinder Repair and Maintenance Workshop at PT XYZ

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A B S T R A C T

PT XYZ is a private company engaged in the 3 Kg LPG maintenance workshop. Activities within the company include retesting, repairing and repainting 3 Kg LPG cylinders. Workers' activities while working sometimes do not pay attention to safety and comfort at work, which can have a negative impact on the worker, such as complaints of pain in the worker's body parts or Musculoskeletal Disorders (MSDs). Ergonomic assessment analysis is needed to understand the condition of workers' joint muscle tissue and bone tissue in carrying out their duties, which can reduce the risk of MSDs while increasing worker performance. This study aims to evaluate worker posture and provide improvements to the work posture of pressing ring painting and shoot ballast operators using the Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA). In the RULA method the work process is at a high level in the screen printing of the bottom of tube 10 so improvements need to be made now. The moderate level is found in the process of pressing hand guard 5 and printing hand guard 5 so improvements need to be made in the near future. In the REBA method, the work process is at a high level in the printing process at the bottom of tube 9, so repairs need to be made immediately. Recommendations or proposed improvements based on RULA and REBA calculations are to make movement changes in the tube body screen printing process, hand guard screen printing. Adding or improving work tools based on anthropometric body measurements, suggestions are given to reduce or resolve problems with complaints of muscle pain in production workers at PT. XYZ.

Keywords: Working Posture, RULA, REBA.

Article History
Received 12 September 23 Received in revised form 1 November 23 Accepted 14 December 23

1. Introduction

Indonesia is a developing country where you can still find many companies that use human labor in the process of moving materials. Many modern industries already use machines to help move materials, but Manual Material Handling (MMH) activities are still needed because they have advantages compared to using tools. Manually moving materials can be done in limited spaces, and to carry out their activities workers rely on human physique in lifting goods which are done manually, which can cause injury or work accidents if done in a way that is not ergonomic[1].

Work systems that are not ergonomic in a company often receive little attention from company management, one part of the system is the workers. Workers usually adopt attitudes and work positions that are less ergonomic. This will have an impact on workers' productivity, efficiency and effectiveness in completing it. The working position in question is the working posture with MMH activities[2].

MMH is a transportation activity carried out by workers that consists of lifting, lowering, pushing, pulling, transporting, and moving goods [3]. Manual movement of goods is the main cause of worker complaints. The increasing level of injuries or accidents that occur to workers can cause a decrease in the work productivity of workers and companies. Apart from that, the increase in injuries also has a personal impact on workers, this is related to system disorders in the human musculoskeletal system. Losses from the impact of increasing injuries also cause material losses resulting from the burden of workers' medical costs as well as worker absenteeism, and a decrease in work quality[4].

The main activities of PT. XYZ is a retester, repair and repainting service for 3 Kg LPG cylinders. As well as other activities, namely replacing repair tubes if they have been prepared or there is a letter from Pertamina. Workers' activities during work sometimes do not pay attention to safety and comfort at work, which can have a negative impact on workers, such as complaints of pain in workers' body parts or Musculoskeletal Disorders (MSDs). Musculoskeletal Disorders are injuries that are often experienced by workers when carrying out manual material

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E-ISSN 2548-4214

lifting activities[5]. Injuries that occur in MSDc include injuries to muscles, nerves, tendons, bones, joints and cartilage caused by work activities[6].

Activities that are often carried out are moving objects in unnatural body positions, static work, and repetitive work that can result in injury because the muscles receive pressure for a long time. Some workers also pay less attention to natural work attitudes due to forcing themselves to achieve targets set by the company. In the process of lifting the tube, workers do not use tools or do it manually. In another process, the worker was found with his back bent and his neck bent with a load of 10 kg lifted from two empty tubes. Lifting done repeatedly will cause muscle work to weaken over time, causing a feeling of fatigue. These activities cause several musculoskeletal complaints which cause pain and affect work productivity.

Ergonomic assessment analysis is needed to understand the condition of workers' joint muscle tissue and bone tissue in carrying out their duties, which can reduce the risk of MSDs while increasing worker performance. One of the assessment tools for work posture that can determine the risk of MSDs is the Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA). RULA is a tool to assess and measure the condition of workers regarding risks arising from work related to disorders of the neck and upper limbs[7]. REBA is a tool to assess and measure the condition of workers regarding risks that occur due to work related to disorders of the legs along with the body and lower trunk[8].

The RULA method was developed in the field of ergonomics which investigates and assesses the working position carried out by the upper body. To assess the posture of the neck, back and upper body, special equipment is needed. Egonomics technology evaluates the strength and activity of muscles that cause injuries caused by repetitive activities. RULA was developed to detect risks to work posters and then make improvements as soon as possible[9].

The REBA (Rapid Entire Body Assessment) method is the result of collaborative work by a team of ergonomists, physiotherapists, occupational experts and nurses who identified around 600 positions in the manufacturing industry. This method is also a tool for postural analysis which is very sensitive in jobs that involve sudden changes in position. Usually caused by unstable or unpredictable container handling. The application of the REBA method is to prevent the risk of injury related to position, especially to the skeletal muscles. This method is useful in preventing risks and can be used to warn that inappropriate working conditions are occurring in the workplace[10].

2. Research methods

This research is a quantitative descriptive research, with data collection techniques through direct observation of the production process at the 3 Kg Gas Cylinder Repair and Maintenance Workshop at PT XYZ by recording operator activities, then determining the angles of the operator's body parts. Apart from that, conducting interviews to fill out the Nordic Body Map (NBM) questionnaire to measure muscle pain in operators. Also know which parts of the operator's body are experiencing complaints, ranging from no pain to very painful.

This research was carried out by analyzing the working posture positions of four workers consisting of operators printing the bottom of the tube, hand guard printing, body printing the tube, and press hand guard.

The data analysis methods used in this research are the REBA (Rapid Entire Body Assessment) and RULA (Rapid Upper Limb Assessment) methods. By calculating the REBA (Rapid Entire Body Assessment) value from the operator's work posture that has been obtained, it can be seen the level of risk and the need for action that needs to be taken to improve work in the 3 Kg Gas Cylinder Repair and Maintenance Workshop. In the RULA (Rapid Upper Limb Assessment) method, the posture, style and movement of an activity will be analyzed which can cause the level of risk generated by that activity.

3. Results and Discussion

Data collection was carried out from June to July 2023 in the production room of PT. XYZ by direct observation and interviews. Researchers analyzed four work postures in the production room that could have a high risk, including: the process of printing the bottom of the tube, printing the hand guard, printing the body of the tube, and the hand guard press. The following is a picture of the four processes:

Table 1. Risky work posture

Number	Picture	Information
1		Screen Printing of the Bottom of the Tube
2		Hand Guard Press
3		Printing the hand guard

4		Printing the body of the tube

3.1 Assessment of Body Posture for Screen Printing of the Bottom of the Tube

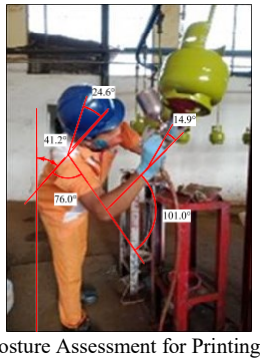

Figure 1. Body Posture Assessment for Printing the Bottom of the Tube

1) Assessment uses the RULA method

a. Group A

1. The position of the upper arm is between a 45º-90º angle so a score of 3
2. The position of the forearm is at an angle >100º so the score is 2+1 because it comes out from the side of the body=3
3. Wrist is between an angle of 0º-15º so score 2
4. The wrist rotation is in the middle position of the score rotation 1
5. Activity score +1 static posture +1 because there are movements that are repeated more than 4 times in 1 minute = 2
6. Load <2 kg then score 0

Group A= 4+2+0=6

b. Group B

1. The neck position is at an angle of 24.6º extension, so the score is 4
2. The body is between an angle of 20º-60º, so the score is 3+1 because the body is tilted to the side = 4
3. Normal foot position then score 1
4. Addition of static posture activity score and repetition value 1+1=2
5. Load score <2 kg then the value is 0

Group B = 7+2+0= 9

c. RULA Score C Calculation

The grand final RULA score in the process of printing the bottom of the tube is 10. Action Level RULA score 10 is at level 4 (high) which requires corrective action now.

2) Assessment uses the REBA method

a. Group A

1. Body position is between the 20º-60º flexion angle so the score is 3 + 1 because the body tilts = 4
2. The neck position is at an angle > 20º extension so the score is 2+1 because the neck is tilted to the side = 3
3. Feet are supported evenly so score 1
4. Load <5 kg then score 0

Group A= 6+0=6

b. Group B

1. The upper arm is at an angle of 45º-90º flexion so a score of 3
2. The forearm has an angle between >100º flexion so score 2
3. Wrist posture is at an angle of 0º-15º flexion so the score is 1
4. Grip 0

Then the value of B = 4+0= 4

c. REBA C score calculation

The grand final C value in the screen printing process for the bottom of the tube is the C+activity table. Activity score +1 static work attitude for more than 1 minute + 1 work that repeats more than 4 times per minute =2. Then the score C= 7+2=9. Action level REBA score 9 is at level 3 high risk, so immediate improvements need to be made.

Body posture in the process of printing the bottom of the tube over a long period of time and even in a short period of time will result in pain in the neck due to the extended and twisted position, pain in the back due to the bent and twisted position, pain in the lower arm due to the position of the forearm out of the body.

3.2 Assessment of Body Posture in the Hand Guard Press

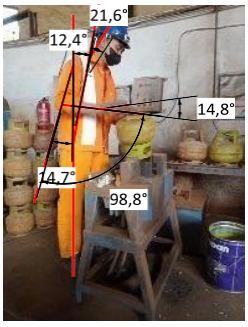

Figure 2. Hand Guard Press

1) Assessment uses the RULA method

a. Group A

1. The position of the upper arm is at an angle of 20º backwards so the score is 1
2. The position of the forearm is between an angle of 60º-100º so the score is 1
3. Wrist is between an angle of 0º-15º so score 2
4. The wrist rotation is in the middle position of the score rotation 1
5. Activity score +1 due to static

6. Load between 2 kg-10 kg then score 1
Group A= 2+1+1=4

b. Group B
1. The position of the neck is between an angle of >20º flexion so a score of 3
2. The body is between an angle of 0-20º then score 2
3. The foot position is balanced then the score is 1
4. Addition of static activity score is +1
5. Load value between 2-10 kg then 1
Group B= 3+1+1=5

c. RULA Score C Table Calculation
The grand final RULA score on the Hand Guard Press is 5. Action Level RULA score 5 is at level 3 (Medium) which requires action in the near future.

2) Assessment uses the REBA method
a. Group A
1. The body position is at an angle of 0º-20º extension so the score is 2
2. The position of the neck is between an angle of >20º flexion so a score of 2
3. Feet are supported evenly so score 1
4. Load <5kg then score 0
Group A= 3+0=3

b. Group B
1. The upper arm is between the 20º extension angle so the score is 1
2. The forearm is at an angle of 60º-100º flexion so the score is 1
3. Wrist posture is at an angle of 0º-15º flexion so the score is 1
4. Grip 0
Group B= 1+0=1

c. REBA C score table calculation
The grand final score of C in the press hand guard process is the C+activity table. Activity score + 1 static work. Then the score C= 2+1=3. Action level REBA score 3 is at low level 1, so improvements may need to be made.
Body posture during the Press Hand Guard process over a long period of time will result in pain in the legs, back and neck.

3.3 Body Posture Assessment in Hand Guard Screen Printing

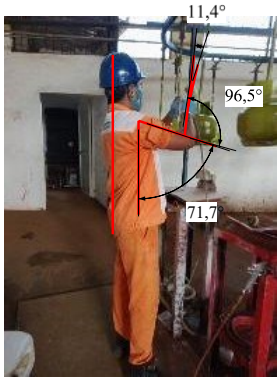

Figure 3. Screen printing of Hand Guard

1) Assessment uses the RULA method
a. Group A
1. The position of the upper arm is between a 45º-90º flexion angle so a score of 3
2. The position of the forearm is at an angle of 60º-100º so the score is 1
3. Wrist is between an angle of 0º-15º so score 2
4. The wrist rotation is in the middle position of the score rotation 1
5. Score 1 repetition of activity
6. Load <2 kg then score 0
Group A= 4+1+0=5

b. Group B
1. The position of the neck is between the angle 0º so the score is 1
2. The body is between the angle 0º (normal) so the score is 1
3. The foot position is not balanced then the score is 2
4. Increase the activity score by 1 repetition
5. Load score <2 kg then score 0
Then group B= 3+1+0=4

c. RULA Score C calculation
The grand final RULA score for Hand Guard Screen Printing is 5. Action Level RULA score 5 is at level 3 (medium) which requires action in the near future.

2) Assessment uses the REBA method
a. Group A
1. The body position is between the 0º natural vertical angle so the score is 1
2. The neck position is between the 0º-20º flexion angle so the score is 1
3. Feet are not supported evenly so score 2
4. Load <5kg then score 0
Then group A= 2+0=2

b. Group B

1. The upper arm is between 45º- 90º flexion so the score is 3
2. The forearm has an angle between 60º-100º flexion so the score is 1
3. Wrist posture is at an angle of 0º-15º flexion so the score is 1
4. Grip 0

Then group B= 3+0=3

c. REBA C score calculation

The grand final score of C in the Hand Guard Screen Printing process is the C+activity table. Activity score + 1 rep. Then the score C= 2+1=3. Action level REBA score 3 is at low level 1, so improvements may need to be made.

Body posture during the Hand Guard Screen Printing process over a long period of time and even in the short term will result in pain in the legs because they are not supported evenly and pain in the forearms.

3.4 Body Posture Assessment in Tube Body Screen Printing

Figure 4. Screen printing of tube body

1) Assessment uses the RULA method

a. Group A

1. The position of the upper arm is between a 20º extension angle so the score is 1
2. The position of the forearm is at an angle of 60º-100º so the score is 1
3. Wrist is between an angle of 0º-15º so score 2
4. The wrist rotation is in the middle position of the score rotation 1
5. Activity score 0
6. Load between 2-10 kg then score 1

Then Group A= 2+0+1=3

b. Group B

1. The position of the neck is between an angle of 10º-20º so score 2
2. The body is between an angle of 0º (normal) so the score is 1+1 tilted body = 2
3. The foot position is not balanced then the score is 2
4. Addition of activity score 0
5. Load score 2kg- 10 kg then score 1

Then group B= 3+0+1=4

c. RULA Score C calculation

The grand final RULA score for screen printing the tube body is 3. Action Level RULA score 3 is at level 2 (small) which requires action sometime in the future.

2) Assessment uses the REBA method

a. Group A

1. The body position is between the natural 0º vertical angle so the score is 1+1 body tilt=2
2. The neck position is between the 0º-20º flexion angle so the score is 1
3. Feet are not supported evenly so score 2
4. Load <5kg then score 0

Then group A= 3+0=3

b. Group B

1. The upper arm is between the 20º extension angle so the score is 1
2. The forearm has an angle between 60º-100º flexion so the score is 1
3. Wrist posture is at an angle of 0º-15º flexion so the score is 1
4. Grip 0

Then group B= 1+0=1

c. Calculation REBA score C

The grand final score of C in the Tube Body Screen Printing process is the C+activity table. Activity score + 0. Then score C= 2+0=2. Action level REBA score 2 is at low level 1, so improvements may need to be made.

Body posture during the Body Tube Screen Printing process over a long period of time will result in pain in the legs because they are not supported evenly and pain in the back, however this level is considered acceptable in the short term.

3.5 Overall RULA and REBA measurement results

Table 2. Overall RULA score

Table	Work process	Worker Activities (RULA)			
		1	2	3	4
A	Upper arm	3	1	3	1
	Lower arm	3	1	1	1
	Wrist	2	2	2	2
	Wrist twist	1	1	1	1
	Muscle use	2	1	1	0
	Force/load	0	1	0	1
	Total Score A	6	4	5	3
B	*Neck*	4	3	1	2
	Trunk	4	2	1	2
	Leg	1	1	2	2
	Muscle use	2	1	1	0
	Force/load	0	1	0	1
	Total Score B	9	5	4	4
C	Table Score A	6	4	5	3
	Table Score B	9	5	4	4
	Table Score RULA	10	5	5	3

- The work activity that has a high level is in the work process of printing the bottom of the tube with a score of 10 so it requires improvement now.
- Medium level work activities include the press hand guard work process with a score of 5 and hand guard screen printing with a score of 5, which require corrective action in the near future.
- Work activities that have a small level are in the tube body screen printing work process with a score of 3 so that improvements are needed in the future or for a long time, which
- can be considered acceptable in the near term.

Table 3. Overall REBA score

Table	Work process	Worker Activities (REBA)			
		1	2	3	4
A	Back	4	2	1	2
	Neck	3	2	1	1
	Foot	1	1	2	2
	Total	6	3	2	3
	Burden	0	0	0	0
	Total Score A	6	3	2	3
B	Upper arm	3	1	3	1
	Forearm	2	1	1	1
	Wrist	1	1	1	1
	Total	4	1	3	1
	Grip	0	0	0	0
	Total Score B	4	1	3	1
C	Tabel Score C	7	2	2	2
	Activity Score	2	1	1	0
	Score REBA	9	3	3	2

- The work activity that has a high level is found in the work process of printing the bottom of the tube with a score of 9 so it requires immediate improvement.
- Work activities that have a small level are in the press hand guard work process with a score of 3, hand guard screen printing with a score of 3 and tube body screen printing with a score of 2 so improvements need to be made in the future or for a long time, which can be accepted in the near term.

3.6 Proposed Improvements

Based on the results of RULA and REBA calculations, it is known that it is necessary to improve working posture to reduce pain or muscle aches that are often experienced by workers, especially in the production room at PT. XYZ. The following are suggestions for improving working posture for each section.

Figure 5. Proposal 1

proposed image 1 on the work process of hand guard press and tube body printing.

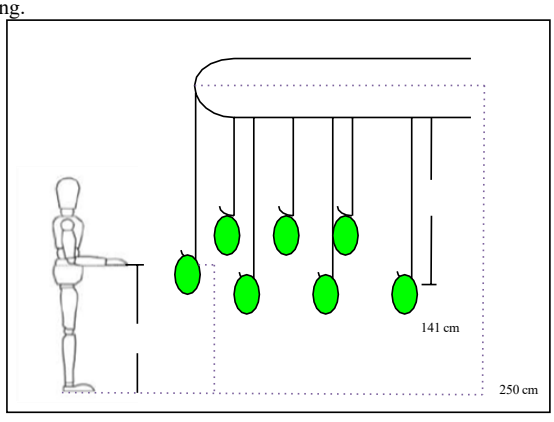

Figure 6. Proposal 2

Proposed image 2 shows the work process of screen printing the hand guard and screen printing the bottom of the tube.

3.8 RULA and REBA Measurement Results after Repair

Table 4. RULA Measurement Results after Repair

Table	Work process	Worker Activities (RULA)			
		1	2	3	4
A	Upper arm	1	1	1	1
	Lower arm	1	1	1	1
	Wrist	1	1	1	1
	Wrist twist	1	1	1	1
	Muscle use	2	1	1	0
	Force/load	0	1	0	1
	Total Score A	3	3	2	2
B	*Neck*	1	1	1	1
	Trunk	1	1	1	1
	Leg	1	1	1	1
	Muscle use	2	1	1	0
	Force/load	0	1	0	1
	Total Score B	3	3	2	2
C	Table Score A	3	3	2	2
	Table Score B	3	3	2	2
	Table Score RULA	3	3	2	2

- Work activities that have a small level include the work process of printing the bottom of the tube with a score of 3 and press hand guard with a score of 3, which requires improvement in the future or for a long time, which can be accepted in the near term.
- Activities that have a minimum level are in the hand guard screen printing process with a score of 2 and tube body screen printing with a score of 2, where the working position is safe and requires no repairs.

Table 5. REBA Measurement Results After Repair

Table	Proses Kerja	Worker Activities (REBA)			
		2	9	13	14
A	Back	1	1	1	1
	Neck	1	1	1	1
	Foot	1	1	1	1
	Total	1	1	1	1
	Burden	0	0	0	0
	Total Score A	1	1	1	1
B	Upper arm	1	1	1	1
	Forearm	1	1	1	1
	Wrist	1	1	1	1
	Total	1	1	1	1
	Grip	0	0	0	0
	Total Score B	1	1	1	1
C	Tabel Score C	1	1	1	1
	Activity Score	2	1	1	0
	Score REBA	3	2	2	1

- Work activities that have a small level include the work process of printing the bottom of the tube with a score of 3, press hand guard with a score of 2 and screen printing of the hand guard with a score of 2, which may need to be improved in the future or over a long period of time, which can be said to be acceptable in near term.
- Activities that have a level that can be ignored are in the tube body printing process with a score of 1, where the working position does not need to be corrected.

4. Conclusion

1) In the RULA method the work process is at a high level in the screen printing of the bottom of tube 10 so improvements need to be made now. The moderate level is found in the process of pressing hand guard 5 and printing hand guard 5 so improvements need to be made in the near future. In the REBA method, the work process is at a high level in the printing process at the bottom of tube 9, so repairs need to be made immediately.
2) Recommendations or proposed improvements based on RULA and REBA calculations are to make movement changes in the tube body screen printing process, hand guard screen printing. Adding or improving work tools based on anthropometric body measurements, suggestions are given to reduce or resolve problems with complaints of muscle pain in production workers at PT. XYZ

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