

## Work Posture Analysis at The Spinning Department of Textile Industry using Rapid Upper Limb Assessment (RULA) Method

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### Abstract

The work posture of a worker affects not only his efficiency but also to his health. To a job with a high repetitive process, a bad posture will make a worker vulnerable to musculoskeletal disorders (MSDs). This study is aimed to analyze the working posture of workers engaged in the textile industry, especially in the spinning department. The work posture assessment is conducted using Rapid Upper Limb Assessment (RULA). The photo took while the worker was doing their work at the production process of yarn is used to analyze the worker's work posture. Some postures were identified under high-risk levels which potentially causing upper limb disorders then it requires immediate change. Recommendation regarding improving the body posture while working is provided.

**Keywords:** textile, industry, work posture, musculoskeletal disorders, RULA method

### 1. Introduction

Most production activities especially conducted in un-automatic machine require an interaction between human as an operator and a machine. When it happens, he will form a work posture. If the work posture formed is incorrect, discomfort during work will occur and fatigue will arise as an impact. Continuous fatigue will make the worker lose focus then the number of errors will increase, productivity will reduce, and a work accident will create easily (Cutsem et al., 2017). In addition, incorrect work posture will lead to work related musculoskeletal disorders (MSDs) (Shamsudin, Vijayakumar, and Daud, 2017). This situation is frequently found in repetitive processes and manual material handling in the hand tool manufacturing. Therefore, MSDs are related to high repetitive processes and working in bad posture (Singht, 2010). In order to improve the worker efficiency, work posture is needed to be evaluated and corrective measures should be adopted to ensure the work posture has performed correctly and MSDs can be avoided. This study is aimed to analyze the working postures of workers engaged in the yarn production at the spinning department of the textile manufacturing X using RULA (Rapid Upper Limb Assessment) Method.

### 2. Material and Methods

The study is conducted in the yarn production at the spinning department of the textile manufacturing X in West Java, Indonesia. At the spinning department, the operators work monotonously and continuously for eight hours. Some task may require the operators to work with bent posture, looking up, tiptoe, and hand stretched up posture. When interviewing with operators were conducted, many complaints regarding feeling sore or pain in the muscles were reported. If there is no changing in the working method, it will impact not only causing MSDs but also effect to worker performance and productivity.

In this study, a camera is used in recording and analyzing work postures. The operator's work postures chosen to be photo are the postures when the operator was doing work element that has an important role in completing the task in each stage of production. Then the pictures taken are analyzed using RULA Technique since the operator tends to use the upper body while he is doing his work. By implementing RULA employee assessment worksheet (Figure 1), the values of the operator's work posture are calculated. Based on this value, the analysis of the actions will be carried out. The following are steps to measure work posture using RULA:

1. Collect the data needed (work posture photos of operators while doing their work).
2. Identify posture angles, types of activities, and activity loads.
3. Measure group posture A (upper arm, lower arm, and wrist).
4. Add group posture A with activity score and load score.
5. Measure group posture B (neck, trunk, and legs).
6. Add group posture B with activity score and load score.
7. Count the grand score in a way combine group posture A and B.

## 8. Analyze the grand score.

The grand score of RULA is classified into 4 action levels. Action level 1 (a score of 1 or 2) indicates that posture is acceptable if it is not maintained or repeated for long periods. Action level 2 (a score of 3 or 4) indicates that further investigation is needed and changes may be required. Action level 3 (a score of 5 or 6) indicates that investigation and changes are required soon. Action level 4 (a score of 7) indicates that investigation and changes are required immediately in order to eliminate or reduce the risk.

## 3. Result and Discussion

The yarn production consists of several stages: blowing, carding, pre-drawing, uni lap, comber, drawing finisher, simplex, ring frame, winding, and packing. Each stage of the production process has different tasks to be completed. Each task may require a different work posture. The main tasks of each stage are shown in Table 1. Figure 2 shows the work posture of the task.

**RULA Employee Assessment Worksheet**

Task Name: \_\_\_\_\_ Date: \_\_\_\_\_

**A. Arm and Wrist Analysis**

**Step 1: Locate Upper Arm Position:**

Step 1a: Adjust...  
If shoulder is relaxed: +1  
If upper arm is abducted: +1  
If arm is supported or person is leaning: -1

**Step 2: Locate Lower Arm Position:**

Step 2a: Adjust...  
If elbow is working across midline or out to side of body: Add +1

**Step 3: Locate Wrist Position:**

Step 3a: Adjust...  
If wrist is bent from midline: Add +1

**Step 4: Wrist Twist:**

Step 4a: Adjust...  
If wrist is twisted in mid-range: +1  
If wrist is at or near end of range: +2

**Step 5: Look-up Posture Score in Table A:**

Using values from steps 1-4 above, locate score in Table A.

**Step 6: Add Muscle Use Score:**

If posture mainly static (i.e. held <10 minutes):  
Or if action repeated occurs 4X per minute: +1

**Step 7: Add Force/Load Score:**

If load < 4.4 lbs. (intermittent): +0  
If load 4.4 to 22 lbs. (intermittent): +1  
If load 4.4 to 22 lbs. (static or repeated): +2  
If more than 22 lbs. or repeated or shocks: +3

**Step 8: Find Row in Table C:**

Add values from steps 5-7 to obtain Wrist and Arm Score. Find row in Table C.

**Table A: Wrist Score**

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

**Table B: Neck, Trunk and Leg Analysis**

**Step 9: Locate Neck Position:**

Step 9a: Adjust...  
If neck is twisted: +1  
If neck is side bending: +1

**Step 10: Locate Trunk Position:**

Step 10a: Adjust...  
If trunk is twisted: +1  
If trunk is side bending: +1

**Step 11: Legs:**

If legs and feet are supported: +1  
If not: -2

**Table B: Trunk Posture Score**

Neck	Trunk Posture Score					
	1	2	3	4	5	6
1	1	2	3	4	5	6
2	2	3	4	5	6	7
3	3	4	5	6	7	8
4	4	5	6	7	8	9
5	5	6	7	8	9	10
6	6	7	8	9	10	11
7	7	8	9	10	11	12
8	8	9	10	11	12	13
9	9	10	11	12	13	14

**Step 12: Look-up Posture Score in Table B:**

Using values from steps 9-11 above, locate score in Table B.

**Step 13: Add Muscle Use Score:**

If posture mainly static (i.e. held <10 minutes):  
Or if action repeated occurs 4X per minute: +1

**Step 14: Add Force/Load Score:**

If load < 4.4 lbs. (intermittent): +0  
If load 4.4 to 22 lbs. (intermittent): +1  
If load 4.4 to 22 lbs. (static or repeated): +2  
If more than 22 lbs. or repeated or shocks: +3

**Step 15: Find Column in Table C:**

Add values from steps 12-14 to obtain Neck, Trunk and Leg Score. Find Column in Table C.

**Table C: Neck, Trunk, Leg Score**

Wrist / Arm Score	Neck, Trunk, Leg Score					
	1	2	3	4	5	6
1	1	2	3	4	5	6
2	2	3	4	5	6	7
3	3	4	5	6	7	8
4	4	5	6	7	8	9
5	5	6	7	8	9	10
6	6	7	8	9	10	11
7	7	8	9	10	11	12
8	8	9	10	11	12	13
9	9	10	11	12	13	14

**Scoring (Final score from Table C)**

1-2 = acceptable posture  
3-4 = further investigation, change may be needed  
5-6 = further investigation, change soon  
7 = investigate and implement change

**RULA Score**

Figure 1 RULA Employee Assessment Worksheet

Table 1 Main task in yarn production

o.	ages	ork Elements
	owing	sert cotton to blowing machine
	rding	onnect the sliver
	rawing	ean the sticking cotton to the can
	mplex	ke simplex bobbins that have been filled with roving
	mplex	stall the roving
	mplex	ke simplex bobbins from creel
	ng Frame	onnect the yarn
	inding	ke ring frame bobbins



a. Insert Cotton to Blowing Machine



b. Connect the Sliver



c. Clean the Sticking Cotton to the Can



d. Take Simplex Bobbins that have been Filled with Roving



e. Installing Roving Simplex on the Creel



f. Takes Bobbins Simplex from the Creel



g. Connect the Yarn



h. Takes Bobbins Ring Frame

Figure 2 Operator's work posture for each main task in yarn production

The following is an example of the work posture assessment for inserting cotton to blowing machine (Figure 2a) using RULA.

1. Group posture A (Table 2)
  - a. Upper arm  
Upper arm forms an angle of  $52^\circ$ , the work value is equal to 3.

- b. Lower arm  
Lower arm forms an angle of 25°, the work value is equal to 2.
- c. Wrist  
Wrist forms an angle of 20°, the work value is equal to 3.
- d. Wrist twist  
Wrist twist is in the middle, the work value is equal to 1.

Table 2 Group posture A in inserting cotton to blowing machine

Upper Arm	Lower Arm	Wrist							
		1		2		3		4	
		Wrist Twist		Wrist Twist		Wrist Twist		Wrist Twist	
		1	2	1	2	1	2	1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	2	3	3	3	4	4
2	1	2	2	2	3	3	3	4	4
	2	2	2	2	2	2	2	4	4
	3	2	3	3	3	3	4	4	5
3	1	2	3	3	3	4	4	5	5
	2	2	3	3	3	4	4	5	5
	3	2	3	3	4	4	4	5	5
4	1	3	4	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	3	3	3	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	7	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

- e. Group posture A score based on Table 2 is 4.
  - f. Activity Score  
Group posture A is added with the activity score, the work is repeated more than 4 times in 1 minute, then it will be scored of 1.
  - g. Load Score  
The lifted load has a mass of few milligrams, the work value is equal to 0.
  - h. The total of group posture A is  $4 + 1 + 0 = 5$ .
2. Group Posture B (Table 3)
    - a. Neck  
Neck forms an angle of 40°, the work value is equal to 3.
    - b. Trunk  
Trunk forms an angle of 50°, the work value is equal to 2.
    - c. Leg  
The leg is in the normal position, the work value is equal to 1.

Table 3 Group Posture B in inserting Cotton to Blowing Machine

Neck	Trunk 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

- d. Group posture B score based on Table 3 is 3.
- e. Activity Score  
Group posture B is added with the activity score, the work is repeated more than 4 times in 1 minute, then it will be scored of 1.

- f. Load Score  
The lifted load has a mass of few milligrams, the work value is equal to 0.
- g. The total of group posture B is  $3 + 1 + 0 = 4$

### 3. Final Score

The final score is a combination of Group Posture A and Group Posture B. The final score can be seen in Table 4.

Table 4 Final score in insert cotton to blowing machine

<i>Score Group A</i>	<i>Score Group B</i>						
	1	2	3	4	5	6	7+
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

Based on Table 4, the final score is equal to 5, this means that inserting cotton to blowing machine include on action level 3. This score indicates that this posture needs an investigation and changes are required soon.

The results of the work posture calculation for each stage using Rapid Upper Limb Assessment (RULA) can be seen in Table 5. The table shows that 3 of 8 tasks are in low risk level posture (action level 2) which require further investigation. For these three tasks, changes may also be needed in the future. While 5 of 8 tasks are in medium (action level 3) and high (action level 4) risk level posture. According to this technique of posture analysis, those tasks require immediately or urgent changing in the way to handle the job then muscular stress experience by the operators because of bad work posture can be eliminated or reduced. From Table 5, it is found that the average value of using RULA technique in yarn production especially at spinning department is 5.25 which is under action level 3. For work posture of bending and reaching has a high value, so it is categorized as a non-ergonomics work posture that are required for investigation and improvement soon. Thus, the workers can perform their operation with minimum load and stress on their bodies.

Table 5 Recapitulation of the value of work posture using RULA

No.	Task	Value	Action Level
1	Insert cotton to blowing machine	5	3
2	Connect the sliver	4	2
3	Clean the sticking cotton to the can	3	2
4	Take simplex bobbins that have been filled with roving	7	4
5	Install the roving	6	3
6	Take simplex bobbins from creel	7	4
7	Connect the yarn	4	2
8	Take ring frame bobbins	6	3

Ghazali et al. (2009) explains that the higher action levels perhaps can not eliminate any risk to the operator since the human body is a complex system. The RULA system provides a guide for helping to recognize the boundary of the more severe situations. Then redesigning the operation can be conducted based on this information. The owner of the industry is supposed to concern about ergonomics. Then only they can improve the worker productivity as well as the company's profit.

#### 4. Conclusion

Using the RULA technique, this study found that there are awkward working postures adopted by the workers in the yarn production especially in the spinning department. More than 50% of the production stages are categories as medium and high risk of musculoskeletal disorders. Then the ergonomically intervention are required in these production sections. RULA provides information regarding a priority order for the task which should be investigated. Eliminating or reducing bad work posture not only minimize musculoskeletal injuries but also improve worker productivity as well as company's profit.

#### 5. Acknowledgment

The authors would like to thank the anonymous reviewers for the very useful comments and suggestions which help us improve the quality of our paper. Moreover, the authors would also like to thank PT X in West Java, Indonesia for allowing us to do a research and providing us with information and understanding of yarn production system.

#### Reference

- Akodu, A. K., and Ashalejo, Z. O. (2019). Work-Related Musculoskeletal Disorders and Work Ability among Hospital Nurses. *Journal of Taibah University Medical Sciences*, 14(3), 252-261.
- Chen, D., Cai, Y., Cui, J., Chen, J., Jiang, H., and Huang, M, C. (2018). Risk Factors Identification and Visualization for Work-Related Musculoskeletal Disorders with Wearable and Connected Gait Analytics System and Kinect Skeleton Models. *Smart Health*, 7(8), 60-77.
- Cutsem, J. V., Marcora, S., Pauw, K. D., Bailey, S., Meeusen, R., and Roelands, B. (2017). The Effect of Mental Fatigue on Physical Performance: A Systematic Review. *Sports Medicine*, 47(8), 1569-1588.
- Glinka, M., Metzger, S., Viggiani, D., and Callaghan, J. (2018). The Effect of Task Type and Perceived Demands on Postural Movements during Standing Work. *Applied Ergonomics*, 69(2018), 146-152.
- Ghazali, M. F., Mat Salleh, M., Zainon, N., Zakaria, S., Asyraf, C. D. M. (2009). RULA and REBA Assessment in Computer Laboratories. *Proceeding of National Symposium on Advancements in Ergonomics and Safety 2009*, 146-149.
- Singh, J., Lal, H., Kocher, G. (2012). Musculoskeletal Disorder Risk Assessment in small scale forging Industry by using RULA method. *International Journal of Engineering and Advanced Technology (IJEAT)*, 1(5), 513-518.