

Work Posture Analysis of Production Machine Operator Using Rapid Upper Limb Assessment (Rula) Method: A Geographical Perspective Study on PT. Bandung Innovation Organic Company, Indonesia

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Abstract

PT. Bandung Innovation Organic (PT.BIO) is a company engaged in the production of organic fertilizers, in carrying out its production activities, it is in accordance with procedures and continues to improve the work system, production system, and management system in order to achieve company goals so that the company can be more efficient. better and able to fulfill market desires and provide satisfaction to consumers, namely from high quality products as well as services provided by the Company. The problem that occurs in the pressing section from the observations made is that workers like to experience pain or soreness in the arm caused by a less ergonomic work position, causing the work to be less than optimal. After analyzing the work posture on the pressing process operator at PT. Bandung Organic Innovation (PT.BIO) using the Rapid Upper Limb Assessment (RULA) method, the results obtained are the value of the level of danger caused by wrong posture and the value obtained is 7, which means that the posture used is not good for health operator. Therefore, it is necessary to check and change the working posture of pressing operators and health checks so as not to cause more serious effects, with a good work posture that will provide comfort for workers, the company must pay attention to it and it is very necessary for maximum work results.

Keywords

Ergonomic, Work Posture, Rapid Upper Limb Assessment (RULA)

To cite this article: Margana, R, R.; Idram, A, H.; Falah, M.; and Fauzi, M. (2021) Work Posture Analysis of Production Machine Operator Using Rapid Upper Limb Assessment (Rula) Method: A Geographical Perspective Study on PT. Bandung Innovation Organic Company, Indonesia. *Review of International Geographical Education (RIGEO)*, 11(1), 613-620. doi: 10.48047/rigeo.11.1.47

Submitted: 20-01-2021 • **Revised:** 15-02-2021 • **Accepted:** 25-03-2021

Introduction

In a company, especially a manufacturing company, the role of humans as workers is still very dominant, even though there are many companies that use machines with high technology. Some companies that still carry out production activities manually, of course, the role of humans is the one who dominates these production activities. One form of activity from the human role is such as transporting goods and operating manual machines. Production activities like this are very flexible when carried out on objects that have a minimum load. However, in its activities, this activity can be risky for workers when lifting heavy weights with the wrong body position, so that it can cause disease in the spine (low back pain) and can be fatal.

In designing work systems, ergonomic aspects must be applied properly so that the risk of accidents caused can be avoided.

Ergonomics is a systematic science for utilizing information about human abilities and limitations in designing a work system so that people can live and work in a better system, namely achieving the desired goals through an effective, efficient, safe and comfortable job (Wong, Ang, Yang, & Crowe, 2021). (Mayer et al., 2021; Tuček, 2020)

In the science of ergonomics, there are principles of movement that can be applied in the design of work systems by taking into account the capabilities and limitations of workers. Appropriate work movements and meet ergonomic principles can increase work efficiency. And vice versa if the design of the work system does not meet the principles of ergonomics, it can cause pain in body parts and fatigue (Nævestad, Elvebakk, & Ranestad, 2021; Wasisto, 2005)

Conditions of work attitudes related to ergonomics aspects and principles are found in the pressing department of organic fertilizer production at PT. Bandung Organic Innovation (PT.BIO). In this department there are two manual machines, each of which is operated by one worker. The activity carried out is the process of pressing a mixture of organic fertilizer ingredients. Working positions in this department include standing, pressing the lever and opening the engine cover.

The problem that occurs from the observations made is that workers like to experience pain or soreness in the arm caused by a less ergonomic work position, causing the work to be less than optimal.

Based on the problems above, the authors conducted this practical work research with the title "Analysis of the Work Position of Production Machine Operators at PT. Bandung Organic Innovation (PT.BIO) Using the Rapid Upper Limb Assessment (RULA) Method"

Theoretical Basis

RULA (Rapid Upper Limb Assessment) is a survey method developed for ergonomic investigations of the workplace where it is associated with upper limb disorders. This method does not require a device to determine the posture of the neck, back, and upper limbs during use of muscle function, and external loads affecting the body (McAtamney & Corlett, 2004).

This method was developed in the field of ergonomics which investigates and assesses the working position performed by the upper body. Assessment using the RULA method requires a little time to complete and perform general scoring on the list of activities that indicate the need for risk reduction caused by physical lifting by the operator. RULA is intended and used in the field of ergonomics with a wide range of fields (Christensen et al., 2020; McAtamney & Corlett, 2004).

This method is used to evaluate posture or attitude, strength and muscle activity that causes repetitive strain injuries, which results in a risk score between one and seven, where the highest score indicates a level that results in a high risk (dangerous) to do at work, but that does not mean that the lowest score will guarantee the work under study is free and ergonomic hazard. Therefore, the RULA method was developed to detect risky work postures and repair them as soon as possible (Lueder & Corlett, 1996).

Research Methodology

Literature study, used to achieve research objectives related to the research topic. The literature study used by the author is by using books and journals as well as research papers and searching the internet related to ergonomics problems. Determination of Method, the method used in this study is to use the Rapid Upper Limb Assessment (RULA) which is one of the methods in ergonomics. Data collection was obtained in two ways, namely direct interviews with workers regarding physical

complaints experienced and the work postures used. Furthermore, documentation of the worker's work posture is carried out for analysis. The study was planned in capital of west Java, Indonesia. It was done purposely since the Bandung was the place easily accessible to the authors regarding its locality and geography so they considered it for the study. Data processing is done by looking at the angle of the upper body from the image data using the Rapid Upper Limb Assessment (RULA) method. Data processing is done by giving a score at each step, then conclusions are drawn. Final analysis, carried out to determine the factors causing the problem and how to overcome them. Conclusion, drawing conclusions from research activities carried out according to the object under study and containing suggestions for improvements and recommendations.

Data Analysis and Processing

Data processing performed using the RULA table consists of 15 steps. Analysis with this method is divided into two parts, namely Arm and Wrist Analysis and Neck, Trunk and Leg Analysis. The following is the working posture data of the pressing process:



Figure 4.1 The Working Posture Data of The Pressing Process:

RULA Employee Assessment Worksheet

A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position: Diagrams show angles from 20° to 90°. Scores range from +1 to +4.

Step 2: Locate Lower Arm Position: Diagrams show angles from 0° to 180°. Scores range from +1 to +4.

Step 3: Locate Wrist Position: Diagrams show wrist flexion/extension from 0° to 180°. Scores range from +1 to +3.

Step 4: Wrist Twist: Diagrams show wrist rotation from 0° to 180°. Scores range from +1 to +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 (static or repeated): +1
If load 22 to 44 lbs (static or repeated): +2
If more than 44 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.

SCORES

Table A: Wrist Posture Score

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

Table B: Neck, Trunk and Leg Score

Neck Posture	Legs		Trunk		Legs		Legs			
	1	2	1	2	1	2	1	2		
1	1	3	2	3	3	4	5	6	7	7
2	2	3	2	3	4	5	6	7	7	7
3	3	3	3	4	4	5	6	6	7	7
4	4	3	3	4	4	5	6	6	7	7
5	4	4	4	5	6	7	7	7	8	8
6	7	7	7	7	8	8	8	8	8	8
7	8	8	8	8	8	8	8	8	8	8

Table C: Neck, trunk and leg score

Wrist and Arm Score	Neck, trunk and leg score						
	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	7	7	7
7	5	6	6	6	7	7	7
8+	5	5	6	6	7	7	7

Scoring: (final score from Table C)
 1 or 2 = acceptable posture
 3 or 4 = further investigation, change may be needed
 5 or 6 = further investigation, change soon
 7 = investigate and implement change

B. Neck, Trunk and Leg Analysis

Step 9: Locate Neck Position: Diagrams show neck flexion/extension from 0° to 180°. Scores range from +1 to +4.

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

Step 10: Locate Trunk Position: Diagrams show trunk flexion/extension from 0° to 60°. Scores range from +1 to +4.

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

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 22 to 44 lbs (static or repeated): +2
If more than 44 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.

Figure 4.2. Table RULA
Sources: McAtamey dan Corlett, 1993

Arm And Wrist Analysis

Step 1: Locate Upper Arm Position

The first step is to analyze the position of the upper arm.

In this position, the upper arm of the worker forms an angle of 25, which means he scores +2. The position of the shoulder is not raised/pressed down, the arm is not away from the body and the arm is not leaning, then the score obtained is +2.

Step 2: Locate Lower Arm Position

The second step is to analyze the position of the lower arm.

In this position the forearm of the worker forms an angle smaller than 60°-100°, which means he gets a score of +1.

Step 3: Locate Wrist Position

The third step is an analysis of the wrist, namely the wrist. The position of the worker's wrist forms an angle of more than 15°. Wrist position does not intersect the midline. So, get a score of +3.

Step 4: Locate Wrist Twist

The fourth step describes the rotational position of the wrist used when working. The worker bends the wrist so that the wrist is in a position at or near the end-range of twist. Because the hand position is not in a normal position, this analysis scores +2.

Step 5: Look-up Posture Score in Table A

In the fifth step, scores are collected starting from the first step to the fourth step. The following are the stages that have been analyzed:

Step 1: Locate Upper Arm Position: +2

Step 2: Locate Lower Arm Position: +1

Step 3: Locate Wrist Position: +3

Step 4: Locate Wrist Twist: +2

In the fifth step, the decision is made using Table A. Wrist Posture Score which uses the score from the first step to the fourth step.

SCORES

Table A: Wrist Posture Score

Upper Arm	Lower Arm	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	3	3	3	3	4	4
2	1	2	3	3	3	3	3	4	4
	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	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	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	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Figure 4.3 Table A: Wrist Posture Score

Step 6: Add Muscle User Score

The sixth step is to determine the muscles used when doing the product manufacturing process. According to the results of research conducted, each product requires an average processing time of five minutes. Because the body position moves statically, the score obtained is +1.

Step 7: Add Force/Load Score

In the seventh step, the analysis carried out is the load of the weight carried by the workers. Because the load carried by the worker is more than 4.4 lbs or 2 kg and is carried out at a time interval, the score obtained is +1.

Step 8: Find Row in Table C

In the eighth step, you will get the value by adding up the values of the fifth to seventh steps.

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.

Figure 4.4 value summary

From the picture above, it can be concluded that in step eight you get a value of +4, in the sixth rare you get a value of +1, in step seven you get a value of +1, so that from the summation the value for step eight is obtained with a score of +6.

Table C: Neck, trunk and leg score

	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

Figure 4.5 Find Row in Table C Neck, Trunk and Leg Score

B. Neck, Trunk, and Leg Analysis

Step 9: Locate Neck Position

In the ninth step is to determine the angle of the neck position. From the picture above, the worker lowers his neck at an angle of 18°. Then it can be taken the decision of the worker to lower his neck by 10°-20°. So, the score obtained is +2.

Step 10: Locate Trunk Position

The tenth step is an analysis of the spine. The position of the worker's spine is bent at an angle of 21° as shown in the picture. This posture includes a bent spine position with an angle of 20°-60° and there is a sideways bending motion, so the score obtained is +3, +1 and +1 and the final score is +5.

Step 10: Locate Trunk Position:

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

Figure 4.6 Point of Locate Trunk Position

Step 11: Legs

In the eleventh step explain the footstool.

In the picture above, it can be seen that the worker's legs are supported by both, and no one has lifted one leg. Then the score obtained is +1.

Step 12: Look-up Posture Score in Table B

The twelfth step is the sum of steps nine to eleven.

From the picture above, it shows that in step twelve the value obtained is +2, the value of the tenth step is +5, and the value of step eleven is +1.

Step 13: Add Muscle Use Score

The thirteenth step is to determine the muscles used when carrying out the product manufacturing process. According to the results of research conducted, each product requires an average processing time of five minutes. Because the body position moves statically, the score obtained is +1.

Step 13: Add Muscle Use Score
 If posture mainly static (i.e. held >10 minutes),
 Or if action repeated occurs 4X per minute: +1

+1

 Muscle Use Score

Gambar 4.6 Nilai Add Muscle Use Score

Step 14: Add Force/Load Score

In the fourteenth step, the analysis carried out is the load of the weight carried by the workers. Because the load carried by the worker is more than 4.4 lbs or 2 kg and is carried out at a time interval, the score obtained is +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

+1

 Force/Load Score

Figure 4.7 Point of Add Force/Load Score

Step 15: Find Column in Table C

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.

+6

 Posture Score B
 +

+1

 Muscle Use Score
 +

+1

 Force/Load Score
 =

+8

 Neck, Trunk & Leg Score

Figure 4.8 Value Summary Find Column in Table C

From the picture above, it can be concluded that in step twelfth you get a +6 value, in step thirteen you get a value of +1, in step fourteen you get a value of +1, so from the summation results you get a value for step fifteen with a score of +8.

Table C: Neck, trunk and leg score

	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

Figure 4.9 Find Column in Table C

Decision:

Decisions can be made using table C using the values of the wrist and arm scores and neck, trunk and leg scores.

Table C: Neck, trunk and leg score

		Neck, trunk and leg score						
		1	2	3	4	5	6	7+
Wrist and Arm Score	1	1	2	3	3	4	5	5
	2	2	3	4	4	5	5	5
	3	3	3	4	4	5	6	6
	4	3	3	4	5	6	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

Figure 4.10 Decision

Scoring: (final score from Table C)

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

7

Final Score

Figure 4.11 Decision

From the picture above, the overall value of the working posture of the pressing process operator is obtained. From the analysis carried out based on the steps, the hazard value of the work posture used by the operator is seven. A score of seven means that the hazard of the working attitude used requires an examination where it is necessary to change the working posture of the pressing operator and health checks are needed so as not to cause more serious effects.

Analysis

Based on the work that has been done on the working posture of the pressing process operator using the Rapid Upper Limb Assessment (RULA) method. The final result on this work posture gets a score of 7 which means it is dangerous to the work attitude used. These results are obtained from the calculation of scores from the steps that are carried out in stages.

Starting from the first step, namely the position of the upper arm. In this position, the upper arm of the worker forms an angle of 25, which means he scores +2. The position of the shoulder is not raised/pressed down, the arm is not away from the body and the arm is not leaning, then the score obtained is +2. Then the second step in the lower arm position. In this position the forearm of the worker forms an angle smaller than 60°-100°, which means he gets a score of +1. The third step is an analysis of the wrist, namely the wrist. The position of the worker's wrist forms an angle of more than 15°. Wrist position does not intersect the midline. So, get a score of +3. The fourth step describes the position of the wrist rotation used when working. Workers bend the wrist so that the wrist is in a position at or near the end-range of twist. Because the hand position is not in a normal position, this analysis scores +2. In the fifth step, the decision is made using Table A. Wrist Posture Score which uses the score from the first step to the fourth step and the score obtained is +4.

The sixth step is to determine the muscles used when doing the product manufacturing process. According to the results of research conducted each product requires an average processing time of five minutes. Because the body position moves statically, the score obtained is +1. Furthermore, in the seventh step, the analysis carried out is the load of the weight carried by the workers. Because the load carried by the worker is more than 4.4 lbs or 2 kg and is carried out at

a time interval, the score obtained is +1. Step eight gets a value of +4, in the sixth rare it gets a value of +1, in step seven it gets a value of +1, so that from the summation the value for step eight is obtained with a score of +6.

The ninth step is to determine the angle of the neck position. The worker lowers his neck at an angle of 18°. Then it can be taken the decision of the worker to lower his neck by 10°-20°. So, the score obtained is +2. The tenth step is an analysis of the spine. The position of the worker's spine is bent at an angle of 21° as shown in the picture. This posture includes a bent spine position with an angle of 20°-60° and there is a sideways bending motion, so the score obtained is +3, +1 and +1 and the final score is +5. In step eleven explain the footstool. The worker's legs are seen in a state of support. Then the score obtained is +1. Step twelve the value obtained is +2, the value of the tenth step is +5, and the value of the eleventh step is +1, from the sum, the result is +6.

The thirteenth step is to determine the muscles used when carrying out the product manufacturing process. According to the results of research conducted, each product requires an average processing time of five minutes. Because the body position moves statically, the score obtained is +1. Then in the fourteenth step the analysis carried out is the load of the weight carried by the worker. Because the load carried by the worker is more than 4.4 lbs or 2 kg and is carried out at a time interval, the score obtained is +1. In the fifteenth step the addition of the twelfth step gets a +6 value, in the thirteenth step it gets a +1 value, in the fourteenth step it gets a +1 value, so that from the summation the value for the fifteenth step is obtained with a score of +8.

Decisions can be made using table C using the values of the wrist and arm score and neck, trunk and leg score

Conclusion

After analyzing the work posture on the pressing process operator at PT. Bandung Innovation Organic (PT.BIO) using the Rapid Upper Limb Assessment (RULA) method, the results obtained are the value of the level of danger caused by wrong posture and the value obtained is 7, which means that the posture used is not good for operator health. Therefore, an examination is needed and a change in the working posture of the pressing operator is needed and a health check is necessary so as not to cause a more serious effect. From the results of the practical work report that has been done, it can be concluded that work posture factors can affect performance at work. A good work posture will provide comfort for workers so it must be considered by the company and is indispensable for maximum work results. From the results of this evaluation the authors can understand and can provide the results of observations made on the company so that it can find out the obstacles that occur.

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