http://jurnal.yudharta.ac.id/v2/index.php/jkie
Journal Knowledge Industrial Engineering
E-ISSN: 2541-4461 | P-ISSN: 2460-0113

Posture Risk Assessment of Mixer Workers in Disc-Pad Plant Using RULA and REBA Methods

Nina Aini Mahbubah[a], **Muhammad Taufiqul Ihsan**[b]
[a,b]Department of Industrial Engineering, Engineering Faculty, Universitas Muhammadiyah Gresik, Indonesia
Corresponding Autor: n.mahbubah@umg.ac.id

Article Info

Article history
Received : May 16, 2026
Revised : August 27, 2026
Accepted : August 28, 2026
Published : August 31, 2026

Keywords: (3-5 words).
RULA;
REBA;
Ergonomics;
Risk;
Musculoskeletal Disorders.

ABSTRACT

An extreme working posture can lead to musculoskeletal disorders, conditions characterized by spinal anomalies. The operators at an upstream automotive manufacturer are prone to fatigue due to intense workloads. This study aims to evaluate the risk of work posture. Ergonomic risk assessment based on the Rapid Upper Limb Assessment (RULA) and the Rapid Entire Body Assessment (REBA) is used as a research method. The study's population comprises three operators. The research stages began with a walk-through survey to identify work activities, followed by photographs of work postures. The study's findings showed that the highest RULA and REBA scores indicate a need for improvement in work methods. The analysis reveals that RULA is more exposed to upper-limb and wrist postures, while REBA sufficiently captures the risk associated with trunk flexion and leg loading. This approach provides a comprehensive risk shape for repetitive tasks, which is often overlooked in single-method studies. The research results also show that implementing ergonomic risk assessment using the RULA and REBA approaches can serve as input for a firm's management to improve work conditions.

DOI: https://doi.org/10.35891/jkie.v13i2.6926

1. Introduction

Musculoskeletal disorders result from prolonged repetitive tasks among workers in the manufacturing industry (Rahman et al., 2025). Many studies have shown that low back pain and shoulder pain are the most common musculoskeletal disorders (Bhandare et al., 2025; Jamshidian et al., 2024; Nur 'ainiyah et al., 2022; Rahman et al., 2025). Musculoskeletal disorders are associated with ergonomic issues, particularly among individuals who perform the same repetitive movements. In addition, empirical studies have found that heavy-duty workloads lead to excessive exertion, such as twisting, bending, and whipping, which can increase the risk of musculoskeletal disorders and early fatigue (Aliaga & Quispe, 2024; Sirikasemsuk et al., 2024).

Work postures are often caused by inadequate facilities, which in turn affect operator health and performance. Early worker fatigue can also lead to occupational diseases and accidents that may result in disability (Rahman et al., 2025). Therefore, enterprises should prioritize health and safety by implementing ergonomic practices throughout their procedures and work environments.

For example, inadequate working posture has been observed among operators at Firm A, a manufacturer of automotive brake parts that produces brake shoes, brake pads, molds, and dies, and has been in operation for at least 50 years. The company operates in a high-demand industry, with production activities that are largely manual and require overtime. To identify inconvenient working postures, interviews were conducted with workers at Firm A, with the results tabulated in Table 1.

Table 1. Interview result

No	Operator	Age (year-old)	Work Experience (years)	Posture discomfort while working			
				Neck	Upper arms	Back	Feet
1.	Operator 1	35	15	√	√	√	√
2.	Operator 2	27	8	√	√		√
3.	Operator 3	37	17	√	√	√	√

Source: Data processing results

The data obtained on work discomfort indicate that activities such as lifting and turning, as well as prolonged standing, can quickly fatigue workers. Additionally, the joints in the waist, upper arms, wrists, and legs can rapidly become sore and painful. This problem is further reinforced by the working hours and overtime.

While empirical evidence shows that RULA and REBA have been applied at various industrial scales, the assessment of ergonomic risks remains relevant . Empirical studies have normally used RULA for upper-body posture analysis and REBA for a more comprehensive assessment of the entire body. However, for operators in the automotive component manufacturing industry, such as Firm A, comprehensive comparisons of the two methods for repetitive activities and heavy loads are limited. This approach is relevant as empirical evidence has primarily focused on large-scale industries with semi-automated facilities. At the same time, Firm A represents an industry that relies on manual labor in certain areas. This object underscores the need to evaluate the suitability of RULA and REBA for industries with similar characteristics, especially for measuring the impact of static and dynamic postures on premature fatigue.

Furthermore, empirical studies have predominantly used RULA and REBA scores without considering overtime. In fact, at Firm A, these factors exacerbated the risk of musculoskeletal disorders. Previous studies used a single method and applied it to workers on modern automotive assembly lines. Meanwhile, this study focused on comparing and integrating the two methods to identify their strengths and weaknesses in the context of repetitive work in a component production line and serves as an example of application in a large-scale industry with ergonomic challenges that has not yet implemented a comprehensive ergonomic approach.

This research contributes to the existing body of knowledge in three specific ways. First, it provides a side-by-side comparison of RULA and REBA sensitivity with a focus on mixer operators in the disc-pad area, which has not been documented in the existing literature. Second, this research identifies posture drivers to this manual material-handling workstation in a large automated plant, including trunk flexion, upper-arm elevation, neck flexion, asymmetrical leg loading, and wrist deviation. Third, it offers posture-driven redesign targets derived from the assessment to guide the translation of action levels into actionable engineering changes for plant management.

The novelty of this study lies in its comparative methodological approach within the disc-pad manufacturing process. Specifically, the study reveals that RULA is more sensitive to upper-limb and wrist postures during the weighing and mixing tasks. At the same time, REBA better captures whole-body risks associated with trunk flexion and leg loading during the collecting task.

This research aims to assess work postures in the mixer section that contribute to musculoskeletal disorders in the back, hands, neck, and feet. The objectives are to identify uncomfortable postures in the mixer section, calculate posture-risk scores, and compare RULA and REBA interpretations in an improvement scenario to minimize the risk posed by these postures.

2. Literature Review

Ergonomic factors related to work posture are important considerations for maintaining satisfactory standing, sitting, and other positions (Aliaga & Quispe, 2024). Irregular postures maintained for extended periods can lead to pain in the affected areas of the body (Sirikasemsuk et al., 2024).

Posture analysis approaches have advanced significantly. It began in 1977 with the application of the OWAS method, followed by the NIOSH method in 1981 (Aliaga & Quispe, 2024). The emergence of the REBA and the RULA method in 1993 has been considered a significant advancement of working posture assessment methods (Sirikasemsuk et al., 2024). These methods, which analyze upper body posture using the angles formed by the work posture, represent the latest in ergonomic assessment techniques.

Furthermore, the RULA method considers loads of the neck and upper body during activities (Pusakanongwati et al., 2022; Sudiarto et al., 2025). It explains that a worker's task will be reflected in a Score. RULA was designed to detect work postures or risk factors that require further investigation (Ferdiansyah & Mahbubah, 2022). Therefore, when a high score is obtained, immediate evaluation and correction of upper-limb work posture should be undertaken, as the core of RULA analysis is upper-body posture analysis (Aslan et al., 2025).

The objectives in measuring worker routine using RULA include identifying musculoskeletal activity related to work posture. Evaluating work posture using RULA also provides scores that can serve as a reference in ergonomic assessments to determine whether the current work posture is acceptable from a health perspective and as a think tank for identifying job attributes related to imperfect work posture.

The REBA is a posture analysis method used to assess an operator's neck, back, arms, wrists, and legs (Hignett & McAtamney, 2000; Hita-Gutiérrez et al., 2020). The REBA method is designed for ease of use and does not require expensive equipment (Gungor & Oguz, 2024; Prirasetyo & Mahbubah, 2021). Inspectors only need a worksheet to assess an activity and a camera to record the worker's movements, and then document them in videos or photographs. The selection of postures to be evaluated is based on the most challenging postures and activities, as identified through worker interviews and observations.

The implementation of the RULA and REBA methods has been effective in addressing musculoskeletal disorders, which can significantly impact productivity. These methods are key in understanding terms such as repetitive strain injury and Repetitive Motion Injury. Although the RULA and REBA approaches can be implemented separately, the combined RULA-REBA approach has been empirically shown to assess the risk of work postures across a range of body angles. The RULA and REBA methods have been widely used to examine ergonomic risk among employees in a variety of industries, including textile, rubber, tap, metal products, warehouses, maintenance service, and automotive (Aslan et al., 2025; Bhandare et al., 2025; Dhonny & Mahbubah, 2025; Jamshidian et al., 2024; Sirikasemsuk et al., 2024; Varghese et al., 2025). Furthermore, the combination of the two methods remains relevant and is used worldwide for ergonomic risk evaluation.

3. Methodology

3.1. Sampling

This observational ergonomic risk assessment was conducted among mixer operators in the Disc-Pad Division of a multinational upstream automotive manufacturer in East Java Province, Indonesia. Disc-Pad is a process of making car brake pads by combining baking plates or iron plates with forming. The research participants comprised three operators representing the population of mixer operators. Therefore, a census sampling method was employed, enrolling all three operators to capture the full range of variability in work practices and postural adaptations within the workstation. The three tasks, namely collecting, weighing, and mixing materials, were selected because they constitute the primary work cycle and were consistently reported by all operators as the most physically demanding activities, based on a walk-through survey and interviews.

The fieldwork has been conducted for six months. The fieldwork activity includes visits to the work area, walk-through observations, worker interviews, posture documentation, scoring, and communication of findings to firm management. Written informed consent was obtained from each of the three operators for image and video capture and for the publication of photographs. Faces are obscured in all figures, and no personal health information was collected. The study protocol and the proposed redesign targets were reviewed and approved by the plant management at Firm A.

The posture observation procedure was conducted as follows. Each operator was observed over three complete work cycles, with at least 10 posture samples captured per task. Still images were taken during normal production activities using a digital camera. The representative posture for each task was selected based on the following criteria: (1) the posture exhibited the most extreme joint angles observed during the work cycle, ensuring worst-case risk assessment; (2) the posture was consistently repeated across all three operators; and (3) the posture corresponded to the phase of the task in which workers reported the highest discomfort during interviews. Joint angles were measured using the angle measurement tool.

For the RULA force score, the criteria were: 0 for loads less than 2 kg, +1 for loads between 2 and 10 kg, and +2 for loads greater than 10 kg. For the REBA load score, the criteria were: 0 for loads less than 5 kg, +1 for loads between 5 and 10 kg, and +2 for loads greater than 10 kg. The coupling score in REBA was assigned based on the quality of the hand-to-object grip: 0 for a good grip with a fitted handle; 1 for an acceptable but suboptimal grip; and 2 or 3 for a poor or unsafe grip. The activity score in REBA was assigned +1 if any body part was static for >1 minute, if the task involved ≥4 repetitions per minute, or if the posture was significantly unstable. In this study, no activity modifier was applied because the observed postures were dynamic and did not meet these criteria.

The load/force scores were determined based on direct observation of the materials handled during each task. For the collecting materials task, the operator handled individual material packages weighing less than 4.4 lbs (2 kg), resulting in RULA force and REBA load scores of 0. For the weighing materials task, the operator handled materials weighing approximately 2-5 kg, resulting in RULA force and REBA load scores of 0. For the mixing materials task, the operator handled a combined load of approximately 2-10 kg, resulting in a RULA force score of +1 and a REBA load score of 0. The coupling scores were assigned based on the quality of hand-to-object contact: for collecting and weighing materials, operators used their bare hands to grip material containers with no fitted handles, resulting in a coupling score of +1 (acceptable but suboptimal grip); for mixing materials, operators used a mixing tool with a fitted handle, resulting in a coupling score of 0 (good grip).

The repetition frequency per minute for each task was determined through direct observation of three complete work cycles per operator. For the collecting materials task, operators performed 2-3 collection movements per minute. During the weighing materials task, operators performed 3-4 weighings per minute. For the mixing materials task, operators performed 3-4 mixing strokes per minute.

These tasks were selected because workers reported discomfort during these activities and because the observations showed visible trunk flexion, upper-limb elevation, wrist deviation, or load handling. Furthermore, the posture assessment was based on still images taken during normal production activities. Joint-angle values were treated as a two-dimensional image. All measurements were performed repeatedly to maintain consistency. The selected postures represent the most extreme positions observed during the work cycle, ensuring that the risk posture assessment captures the worst-case scenario for each activity. The values used as inputs for ordinal RULA and REBA scoring bands, as well as the exact numerical angles, are retained to explain the scoring interpretation, which is based on the corresponding RULA and REBA categories. RULA scoring followed the original upper-limb, neck, trunk, leg, muscle use, and force/load steps described by (McAtamney & Nigel Corlett, 1993) and in the RULA worksheet (Hedge, 1993). REBA scoring followed the neck, trunk, leg, upper arm, lower arm, wrist, coupling, load, and activity steps described by (Hignett & McAtamney, 2000) and in the REBA worksheet (Hedge, 2008).

3.2. Data Collection and Measurements

The data analysis used the RULA and REBA sequences. The stages taken in calculating the RULA score are as follows (Hedge, 1993; McAtamney & Nigel Corlett, 1993):

- Analyze the position of the upper arm by observing the angle formed.
- Analyze the position of the forearm by observing the angle formed.
- Analyze the wrist position by observing the angle formed.
- Analyze the movement of the wrist by observing how far the wrist rotates from its axis. Review the posture scores in Table A, based on the scores from stages 1 to 4. Add 1 if the posture tends to be static or if an activity is repeated at least 4 times per minute. Add a score if the observed worker is carrying a specific load. Add the scores from stage 5 to stage 6, and from stage 7 to obtain the Wrist and Arm values, then find the values in row C of Table C.
- Analyze the neck position by observing the angle formed, as shown in the image below. Add 1 to this value if the neck rotates left or right.
- Analyze the spine position by observing the angle formed, as shown in the image below. Add 1 to this value if the spine rotates or tilts to the left or right. Observe whether the feet support the body. If they support the body (for example, when standing or squatting), add 1, and if they do not support the body (for example, when sitting or lying down), add 2. Look at the posture score in Table B, based on the scores in steps 9 to 11. Add 1 if the posture is static or if an activity is repeated at least 4 times per minute. Add a score if the observed worker is carrying a specific load. Add the scores from steps 12 to 14 to obtain the Neck, Trunk, and Leg scores, then find the scores in the columns of Table C.
- Steps 12 to 15 of the RULA Method: Determine the final score for the RULA method based on the scores obtained from the corresponding rows and columns in Table C, then determine the conclusion based on the evaluation results according to the score category. There are four levels with an explanation of each action level in the RULA method as follows (McAtamney & Nigel Corlett, 1993):
- Level 1: A score of 1 or 2 implies that the worker has performed the work with good working posture, and there is no risk of injury due to their working posture.

- Level 2: A score of 3 or 4 shows that the worker is performing the work in a position that could cause injury. The starting point must be reviewed, and changes or actions taken to easily bring the score back to level 1, ensuring the worker's safety.
- Level 3: A score of 5 or 6 indicates a poor posture, which can lead to injury. Therefore, work postures at this level must be reviewed and changed in the future to prevent injury.
- Level 4: A score of 7 indicates that the worker is performing work in a very high-risk posture that could quickly lead to injury. Therefore, changes must be made immediately with recommendations appropriate to the current situation.

The cycles in assessing posture using the REBA approach are as follows (Hedge, 2008; Hignett, S., 2000):

- Analyze the neck position by observing the angle formed, as shown in the image below. A score of 1 is added to this score if the neck rotates or turns to the left or right.
- Analyze the spine position by observing the angle formed, as shown in the image below. A score of 1 is added to this score if the spine rotates or tilts to the left or right.
- Analyze the leg position by observing the position formed, as shown in the image below. A score of 1 is added if the knee forms an angle of 30° to 60°. A score of 2 is added to the leg score if the knee forms an angle greater than 60°.
- Look at the posture score in Table A based on the scores from steps 1 to 3. Add a score if the observed worker is carrying a specific load. Add the scores from steps 4 and 5 to obtain Score A, then find the row corresponding to Score A in Table C.
- Analyze the position of the upper arm by observing the angle formed, as shown in the image below. Add 1 to this score or subtract one if there is any other movement of the upper arm. Analyze the position of the forearm by observing the angle formed from its normal position. Analyze wrist movement by observing how far the wrist rotates from its axis.
- Look at the posture score in Table B based on the scores from steps 7 to 9. Observe the worker's hands when holding or grasping objects. The more limited the handling facilities or the more difficult it is for the worker to hold or grasp objects, the higher the score.
- Determine Score B by adding the scores from steps 10 and 11, then match the Score B value in column C of Table C with the score A value from Step 6 to obtain the Score in Table C.
- Determine the Activity Score by observing whether one or more body parts of the worker are in a static position for more than 1 minute, the worker performs at least four repetitions in 1 minute, or the activity significantly changes the body's posture and makes it unstable. Then, add the Table C value to the Activity Score to obtain the final REBA score.

4. Results and Discussion

4.1. Results

The core activities identified from interviews and the walk-through survey were collecting, weighing, and mixing materials. The posture angles during workers' activities, the RULA and REBA calculation stages, and the final scores are summarized in Table 2, followed by a comprehensive scoring calculation.

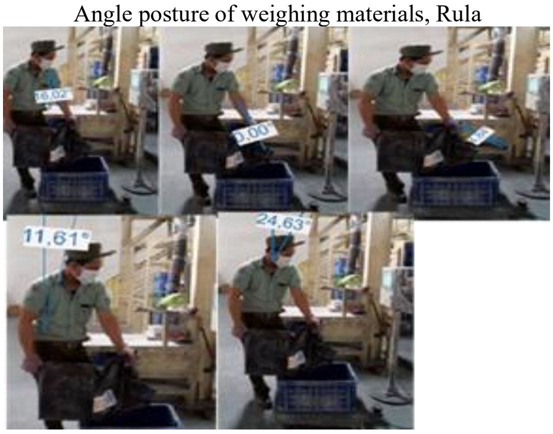
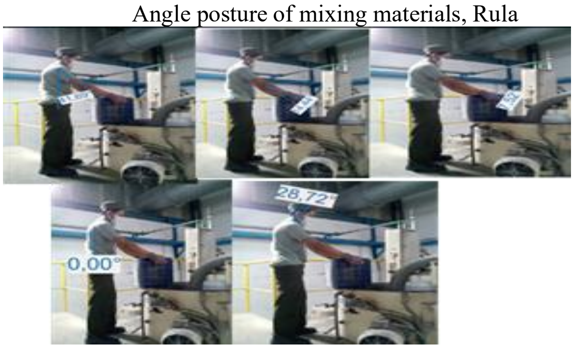
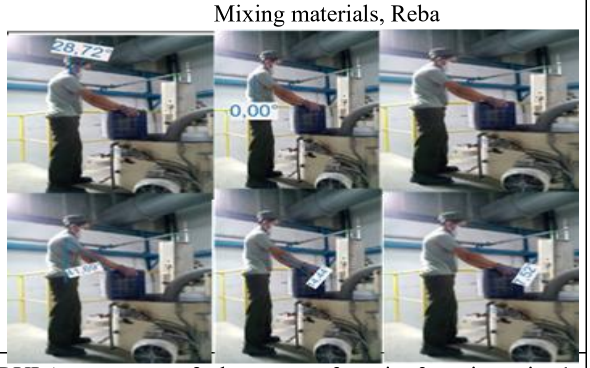
Posture image on the designed task	
Angle posture for Collecting materials, Rula 	Collecting materials, Reba 
Division-level scoring for collecting materials	RULA: upper arm 3, lower arm 2, wrist 1, wrist twist 1, neck 1, trunk 4, legs 1; Table A 3, Table B 5, final 4. REBA: neck 1, trunk 4, legs 1, upper arm 3, lower arm 2, wrist 2, coupling 1; Score A 3, Score B 6, Table C 5, final 5.
Angle posture of weighing materials, Rula 	 Weighing materials, Reba
Division-level scoring for weighing materials	RULA: upper arm 1, lower arm 3, wrist 2, wrist twist 1, neck 4, trunk 2, legs 2; Table A 3, Table B 3, final 3. REBA: neck 3, trunk 2, legs 2, upper arm 2, lower arm 2, wrist 2, coupling 1; Score A 4, Score B 4, Table C 4, final 4.
Angle posture of mixing materials, Rula 	Mixing materials, Reba 
Group scoring for Mixing materials	RULA: upper arm 2, lower arm 3, wrist 3, wrist twist 1, neck 3, trunk 1, legs 1; Table A 3, Table B 3, final 4. REBA: neck 2, trunk 1, legs 1, upper arm 2, lower arm 2, wrist 2, coupling 0; Score A 1, Score B 3, Table C 1, final 1.

Figure 1. Angle of working posture of collecting, weighing, and mixing, and calculation results of RULA and REBA score

Source: Data processing results

The following presents the complete RULA and REBA scoring calculations for each activity, with intermediate scores verified against the original RULA and REBA worksheets.

RULA scoring for collecting materials. Step 1: Locate Upper Arm Position. The upper arm forms an angle of 76.23° to the body axis. Score: +3 on angle 45^0 - 90^0. Shoulder not raised: 0. Arm not abducted: 0. No support: 0. Total: 3. Step 2: Lower Arm Position. The lower arm forms an angle of 14.30°. Score: +2. No adjustment for arm crossing midline. Total: 2. Step 3 and Step 4: Wrist Position & Wrist Twist. The wrist is at 0.0°, with no bending in this position. Score: +1. The wrist position is twisted in the mid-range. Score: +1. Step 5: Table A Score. From RULA Score: 3. Step 6 – Step 8: Add Muscle Use Score, Add Force/Load Score, Find Row in Table C. The posture is not static, so in step 6 (Score: +0), there is indeed a load being lifted, but it is <4.4 lbs. Score: 0 Based on the above, add up the scores in steps 5 to 7 to find out the row value in Table C. Score: 3+0+0 = 3. Step 9: Locate Neck Position. The neck position forms an angle of 3.02 to the normal axis of the body, and there is no bending or curvature. Score: +1.

Step 10: Locate Trunk Position. The angle formed by the body and its normal axis is 63.77 °, with no bend or curve. Score: +4. Step 11: Legs. The worker steps easily on the floor. Score: +1. Step 12: Look-up Posture Score in Table B. Table B RULA Score: 5. Step 13 – Step 15: Add Muscle Use Score, Add Force/Load Score, Find Column in Table C. In step 13 (Score: +0), there is indeed a load being lifted, but it is <4.4 lbs. Score: 0. The next stage was to add up the scores in steps 12 to 14 to find out the column value in Table C. Score: 5+0+0 = 5. Step 14: The RULA final score is 4.

The assessment results using the REBA method for the collecting materials posture are based on Table 2. Step 1: Locate Neck Position. The neck position forms an angle of 3.02° relative to the body's normal axis. Score: +1. Step 2: Locate Trunk Position. The angle formed by the trunk and the normal axis of the body is 63.77°. Score: +4. Step 3: Legs. The worker's feet are resting on the base and form a normal angle. Score: +1. Step 4: Look up Posture Score in Table A. Table A REBA Score: 3. Step 5-Step 6: Add Force/Load Score, Score A Find Row in Table C. The load lifted is <11 lbs with Score: 0. Based on the above, add the scores in step 4 and step 5 to find out the row value in Table C. Score: 3+0 = 3. Step 7: Locate Upper Arm Position. The posture above is one in which the upper arm forms an angle of 76.23° with the body axis. The shoulder position is not raised, and the upper arm is not abducted or away from the body axis. The operator also does not get support from other objects. Score: +3. Step 8: Locate Lower Arm Position. The posture shown above places the lower arm at an angle of 14.30 °. The arm position is neither away from nor towards the body. Score: +2. Step 9: Locate Wrist Position. The wrist is at 0.0°, with no bending; Score: +1, mid-range wrist flexion. Score: +1, so the score for step 9 is 1 + 1 = 2. Step 10: Look-up Posture Score in Table B. Table B REBA Score: 5. Step 11-Step 12: The grip is considered good because the grip fits the hand, but is not acceptable with other bodies. Score: +1 Based on the above, add up the scores in step 10 and step 11 to find out the row value in table C Score: 5+1=6. Step 13: Activity Score. Initially, based on the values obtained from the calculations in steps 6 and 12, the author gets a posture value in Table C of Score: 5. The next step is to add the value of Table C and the activity value to get the final result. The activity carried out involves the worker not being in a static posture. Score: +0 Total Score: 5+0=5.

The work breakdown for weighing materials for the RULA assessment can be captured in five images, as shown in Table 2. Step 1: Locate the Upper Arm Position. The posture shown above has the upper arm at an angle of 16.02° to the body axis. The shoulder is not raised, and the upper arm is not abducted or moved away from the body axis. The operator also does not get support from other objects. Score: +1. Step 2: Locate the Lower Arm. The posture above shows the lower arm at an angle of 0.00 °. Score: +2, the position of the arm is away from the body. Score: +1. Score = 2 + 1 = 3. Step 3 and Step 4: Locate Wrist Position & Wrist Twist. The wrist angle is 4.84°, with no bending in this position. Score: +2. The wrist position is twisted at mid-range. Score: +1. Step 5: Look-up Posture

Score in Table A. RULA Score: 3. Step 6 – Step 8: Add Muscle Use Score, Add Force/Load Score, Find Row in Table C The posture is not in a static condition, so in step 6: Score: +0 there is indeed a load being lifted but the load being lifted is <4.4 lbs Score: 0 Based on the above, add up the scores in steps 5 to step 7 to find out the row value in Table C. Score: 3+0+0 = 3.

Step 9: Locate Neck Position. The neck position forms an angle of 24.63° with the body's normal axis. Score: +3, and the neck is bent to the left; then the score is +1. For Step 9, the Score is +4. For Step 10, locate the Trunk Position. The angle formed by the body and the normal axis of the body is 11.61 °. Score: +2. Step 11: Legs. The worker's feet are easily on the floor. However, the body weight is on only one leg, namely the right, with a Score of +2. Step 12: Look up the Posture Score in Table B. Table B RULA score 3 (neck 4, trunk 2, legs 2). Step 13 – Step 15: Add Muscle Use Score, Add Force/Load Score, and Find Column in Table C. The posture is not static, so in step 13 (Score: +0), there is indeed a load being lifted, but it is <4.4 lbs. Score: 0. Based on the result, then add up the scores in steps 12 to 14 to find out the column value in Table C. Score: 3+0+0 = 3. Final Step: The RULA score is 3.

Table 2 presents the REBA posture images for weighing materials. Step 1: Locate Neck Position. The neck forms an angle of 24.63° with the body's normal axis. Score: +2 and is bent to the left, so score +1. For Step 1, score: +3. Step 2: Locate Trunk Position. The angle formed by the trunk and the normal axis of the body is 11.61°. Score: +2. Step 3: Legs. The load rests on one leg, forming a normal angle. Score: +2. Step 4: Look up Posture Score in Table A. Step 5-Step 6: Add Force/Load Score, Score A, Find Row in Table C. The load lifted is <11 lbs., so Score: 0. Based on the above, add the scores in step 4 and step 5 to find out the row value in Table C. Score: 5+0 = 4.

Step 7: Locate Upper Arm Position. The posture shown above has the upper arm forming a 16.02° angle with the body axis. Score: +1, the shoulder position is not raised, and the upper arm is not abducted. Score: 0, but away from the body axis. Score: +1. The operator also does not receive support from other objects. Score: 0. So 1+1=2. Step 8: Locate Lower Arm Position. The posture above shows the lower arm at an angle of 0.0 °. Arm position. Score: +2. Step 9: Locate Wrist Position. The wrist angle is 4.84°, with no bending in this position. Score: +1 wrist position is bent in the mid-range. Score: +1, so the score for step 9 is 1 + 1 = 2. Step 10: Look up the Posture Score in Table B. Step 11-Step 12: The grip is considered good because it fits the hand and is light. However, it is not for other body parts. Score: +1 Based on the above, add the scores in steps 10 and 11 to find the row value in Table C. Score: 3 + 1 = 4. Step 13: Activity Score. Criteria for assessing worker activity. Based on the values obtained from the calculations in steps 6 and 12, the author initially assigned a posture score of 4 in Table C. The next step is to add the table C score and the activity score to obtain the final result. The activity carried out involves the worker not being in a static posture. Score: +0. Final REBA score: 4 + 0 = 4.

The RULA Posture Assessment for the Mixing Materials Process is presented in Table 2. Step 1: Locate Upper Arm Position. The posture shown above has the upper arm at an angle of 41.69° to the body axis. The shoulder position is not raised, and the upper arm is not abducted or away from the body axis. The operator also does not get support from other objects. Score: +2. Step 2: Locate Lower Arm Position. The posture shown above places the lower arm at an angle of 14.44 °. Score: +2, but the arm is away from the body, Score: +1, so Score: 2 + 1 = 3. Step 3 and Step 4: Locate Wrist Position & Wrist Twist. The wrist angle is 7.52°, indicating a bent position. Score: 2 + 1 = 3. As shown in Figure 4.4, the wrist is bent in the mid-range. Score: +1. Step 5: Look up Posture Score in Table A.

Step 6 – Step 8: Add Muscle Use Score, Add Force or Load Score, and Find Row in Table C. The posture is not static, so in step 6: Score: +0, a load is lifted, but it is 4.4-22 lbs. Score: +1 Based on the above, add up the scores in steps 5 to 7 to find out the row value in Table C. Score: 3+0+1 = 4. Step 9: Locate Neck Position. The neck position forms an angle of 28.72° with the body's normal axis.

Score: +3. Step 10: Locate Trunk Position. The angle formed by the body and the normal axis of the body is 0.0 °. Score: +1. Step 11: Legs. The worker's feet are easily on the floor. Score: +1. Step 12: Look-up Posture Score in Table B. Table B RULA Score: 3. Step 13 – Step 15: Add Muscle Use Score, Add Force/Load Score, Find Column in Table C. The posture is not static, so in step 13: Score: +0, a load is lifted, but it is 4.4-22 lbs. Score: +1 Based on the above, add up the scores in steps 12 to 14 to find out the column value in Table C. Score: 3+0+1 = 4. Final Step: The final RULA score from Table C on Row 4 and Column 4 = 4.

Table 2 presents the REBA posture images for mixing materials. Step 1: Locate Neck Position. The neck position forms an angle of 28.72° with the body's normal axis. Score: +2. Step 2: Locate Trunk Position. The angle between the trunk and the normal axis of the body is 0.0°. Score: +1. Step 3: Legs. The worker's feet are supported on the base and form an angle normal to the body. Score: +1. Step 4: Look up the Posture Score in Table A. Step 5-Step 6: Add the Force/Load Score, Score A, and Find Row in Table C. The load lifted is <11 lbs, so Score: 0. Based on the above, add the scores in steps 4 and 5 to find the row value in Table C. Score: 1+0 = 1. Step 7: Locate the Upper Arm Position.

The posture shows the upper arm forming an angle of 41.69 ° with the body axis. Score: +2. The shoulder position is not raised, the upper arm is not abducted, and no other object supports the operator. Score: +2. Step 8: Locate the Lower Arm Position. The posture above shows the lower arm forming an angle of 14.44 °. Score: +2. Step 9: Locate the Wrist Position. The wrist is bent at a 7.52° angle. Therefore, the Score for Step 9 is 1 + 1 = 2. Step 10: Look up the Posture Score in Table A. Step 11-12: The grip is considered good because it fits the hand and is light. Score: +0 based on the above, add up the scores in step 10 and step 11 to find out the row value in table C Score: 3+0=3. Step 13: Activity Score. Initially, based on the values obtained from the calculations in steps 6 and 12, the author gets the posture value in Table C: Score = 1. The next step is to add the Table C value and the activity value to obtain the final result: Score: +0. Final REBA Score: Table C Score + activity = 1 + 0 = 1. The assessed RULA and REBA scores are summarized in Tables 3-7.

Table 2. Summarizing RULA and REBA Scoring Components

Activity	Method	Upper arm	Lower arm	Wrist	Wrist twist	Neck	Trunk	Legs	Table A	Table B	Muscle/ Activity	Force /load	Coupling	Final Score
Collecting	RULA	3	2	1	1	1	4	1	3	5	0	0	N/A	4
Collecting	REBA	3	2	2	N/A	1	4	1	3	5	0	0	1	5
Weighting	RULA	1	3	2	1	4	2	2	3	3	0	0	N/A	3
Weighting	REBA	2	2	2	N/A	3	2	2	4	3	0	0	1	4
Mixing	RULA	2	3	3	1	3	1	1	3	3	0	1	N/A	4
Mixing	REBA	2	2	2	N/A	2	1	1	1	3	0	0	0	1

Source: Data processing results

Table 3. RULA Table A and Table B Reference Scores

RULA Table A (wrist/upper arm combination	Wrist score 1	Wrist score 2	Wrist score 3	Wrist score 4
Upper arm 1, Lower arm 1	1	2	3	4
Upper arm 1, Lower arm 2	2	3	4	5
Upper arm 1. Lower arm 3	3	4	5	6
Upper arm 2, Lower arm 1	2	3	4	5
Upper arm 2, Lower arm 2	3	4	5	6

Upper arm 2, Lower arm 3			4	5	6	7
Upper arm 3, Lower arm 1			3	4	5	6
Upper arm 3, Lower arm 2			4	5	6	7
Upper arm 3, Lower arm 3			5	6	7	8
Upper arm 4, Lower arm 1			4	5	6	7
Upper arm 4, Lower arm 2			5	6	7	8
Upper arm 4, Lower arm 3			6	7	8	9
RULA Table B (neck/Trunk Combination	Trunk score 1	Trunk score 2	Trunk score 3	Trunk score 4	Trunk score 5	Trunk score 6
Neck 1, Legs 1	1	2	3	4	5	6
Neck 1, Legs 2	2	3	4	5	6	7
Neck 2, Legs 1	2	3	4	5	6	7
Neck 2, Legs 2	3	4	5	6	7	8
Neck 3, Legs 1	3	4	5	6	7	8
Neck 3, Legs 2	4	5	6	7	8	9
Neck 4, Legs 1	4	5	6	7	8	9
Neck 4, Legs 2	5	6	7	8	9	10

Source: Data processing results

Table 4. RULA Table C Final Score Matrix

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8+
Row 1	1	2	3	3	4	5	5	5+
Row 2	2	2	3	4	4	5	5	5+
Row 3	3	3	3	4	4	5	6	6+
Row 4	3	3	3	4	5	6	6	6+
Row 5	4	4	4	5		7	7	7+
Row 6	4	4	5	6	6	7	7	7+
Row 7	5	5	6	6	7	7	7	7+
Row 8+	5+	5+	6+	7+	7+	7+	7+	7+

Source: Data processing results

Table 5. REBA Table A and Table B Reference Score

REBA Table A (neck/trunk/leg combination)					
Neck	Trunk 1	Trunk 2	Trunk 3	Trunk 4	Trunk 5
Legs 1					
Neck 1	1	2	3	4	5
Neck 2	2	3	4	5	6
Neck 3	3	4	5	6	7
Neck 4	4	5	6	7	8
Legs 2					
Neck 1	2	3	4	5	6
Neck 2	3	4	5	6	7
Neck 3	4	5	6	7	8
Neck 4	5	6	7	8	9
REBA Table B (upper arm/lower arm/wrist combination)					
Upper arm	Lower arm 1	Lower arm 2		Lower arm 3	
Wrist 1					
Upper arm 1	1	2		3	
Upper arm 2	2	3		4	

Upper arm 3	3	4	5
Upper arm 4	4	5	6
Wrist 2			
Upper arm 1	2	3	4
Upper arm 2	3	4	5
Upper arm 3	4	5	6
Upper arm 4	5	6	7
Wrist 3			
Upper arm 1	3	4	5
Upper arm 2	4	5	6
Upper arm 3	5	6	7
Upper arm 4	6	7	8

Source: Data processing results

Table 6. REBA Table C

	Score B 1	Score B 2	Score B 3	Score B 4	Score B 5	Score B 6	Score B 7	Score B 8	Score B 9	Score B 10	Score B 11	Score B 12
Score A 1	1	1	1	2	3	3	4	5	6	7	7	7
Score A 2	1	2	2	3	4	4	5	6	6	7	7	8
Score A 3	2	3	3	3	4	5	6	7	7	8	8	8
Score A 4	3	4	4	4	5	6	7	8	8	9	9	9
Score A 5	4	5	5	5	6	7	8	9	9	10	10	10
Score A 6	5	6	6	6	7	8	9	10	10	11	11	11
Score A 7	6	7	7	7	8	9	10	11	11	12	12	12
Score A 8	7	8	8	8	9	10	11	12	12	13	13	13
Score A 9	8	9	9	9	10	11	12	13	13	14	14	14
Score A 10	9	10	10	10	11	12	13	14	14	15	15	15
Score A 11	10	11	11	11	12	13	14	15	15	16	16	16
Score A 12	11	12	12	22	13	14	15	16	16	17	17	17

Source: Data processing results

Overall, the assessed RULA and REBA scores are summarized in Table 8.

Table 7 RULA and REBA Final Score Interpretation

Collecting materials	RULA 4: Action level 2 means further investigation and change may be needed. REBA 5: medium risk means investigation and change are required. Primary drivers: trunk flexion and upper-arm elevation.
Weighing materials	RULA 3: Action level 2 means investigation and change may be needed. REBA 4: medium risk, with the main drivers due to neck flexion, bending, one-leg loading, and arm away from the body.
Mixing materials	RULA 4: action level 2. Recommendation for further investigation and possible change may be needed. REBA 1: negligible upper-limb and wrist posture, with relatively neutral trunk and legs.

Source: Data processing results

4.2. Discussion

4.2.1. Comparative Analysis of RULA and REBA Results and Identification of Posture Risk Factors

The RULA and REBA evaluations suggest that further assessment and corrective actions are necessary for the collection and weighing of materials. The most significant differences were observed in the mixing posture: RULA scored it at level 2, while REBA indicated minimal risk with a score of 1, highlighting the distinct methodologies in scoring body positions.

In the mixing activity, RULA assigned a total score of 4, factoring in wrist, upper arm, lower arm, force/load, and neck scores, while neutral trunk and leg positions influenced REBA's score of 1. For the collection task, both methods indicated increased risk: RULA scored 4, and REBA scored 5, driven by factors such as trunk flexion and REBA-specific coupling penalties.

For the weighing task, RULA with score 3 and REBA with score 4 were more aligned, both highlighting (Sirikasemsuk et al., 2024) neck flexion and uneven leg loading as key risk factors (Gungor & Oguz, 2024). The results fall with (Bhandare et al., 2025) in previously (Jamshidian et al., 2024) reported ranges for similar manual manufacturing tasks, highlighting ergonomic risks, especially in the disc-pad sector. Relying solely on REBA for the mixing task would have overlooked upper-limb posture issues identified by RULA. At the same time, RULA alone would underestimate whole-body risks in collecting tasks reflected by REBA.

The RULA and REBA methods for examining posture-related risk factors can also be aligned with other methods, which can be used not only to broaden exposure but also to enrich the selection of suitable approaches. Furthermore, such an integrated method has been supported by empirical findings used OWAS and NBM as complementary approaches alongside RULA and REBA, yielding complete results for assessing posture risk (Prasetyo et al., 2026; Purwanto et al., 2026; Varghese et al., 2025).

The comprehensive analysis illustrates that material collection is influenced by trunk flexion and upper-arm elevation, whereas weighing tasks are affected by neck position and arm extension. In the mixing posture, REBA's low score indicated neutral trunk and leg positions, but RULA flagged the upper-limb and wrist posture for review.

4.2.2. Linkage Between Identified Posture Risk Factors and Proposed Ergonomic Redesign Recommendations

The redesign recommendations in Table 9. are linked to specific posture risk factors identified through RULA and REBA assessments. Each intervention addresses a factor contributing to elevated scores and explains the expected risk reductions based on the scoring mechanisms.

For the collecting task, the main issues were trunk flexion and upper-arm elevation. Raising the material presentation height to knee-to-elbow level directly targets these by reducing trunk flexion to below 20° and upper-arm elevation to under 45°. This would lower the trunk score from +4 to +1 or +2 and the upper-arm score from +3 to +1 or +2, potentially reducing the RULA score from 4 to 2 and the REBA score from 5 to 3.

In the weighing task, primary factors were neck flexion, asymmetrical leg positioning, and working arms away from the body. Proposed interventions such as a turntable, anti-fatigue mats, and repositioning scales aim to address these issues. Reducing neck flexion to below 20° would lower the neck score from +4 to +2 or +3, and correcting leg and arm positions would further reduce the leg and lower-arm scores. This could decrease the final RULA score from 3 to 2 and the REBA score from 4 to 2 or 3.

For the mixing task, wrist deviation and upper-limb posture were the main issues. Using smaller tilt bins or neutral grip tools would help, reducing the wrist score from +3 to +1 and lowering the RULA score to 2 or 3, while the REBA score remains low due to neutral trunk and leg positions.

These recommendations should be validated in future studies assessing post-redesign RULA and REBA scores, along with worker feedback. Adjustments to workers' posture are expected to lower risk, for example, by raising the presentation height by about 10 cm. This estimate should be confirmed with post-redesign assessments.

Table 8. Implementable Redesign Targets Derived from Final Scores

Posture driver	Redesign the target scenario and estimated scoring effect
Trunk flexion during collecting materials	Goal: keep routine trunk flexion below approximately 20 degrees where feasible. Control: Raise the material presentation height and place frequently used bins at knee-to-elbow height. Expected outcome: lower trunk score and RULA/REBA action level.
Upper-arm elevation and extended reach	Goal: keep upper-arm elevation below approximately 45 degrees and reduce horizontal reach. Control: move bins closer and use shallow or tilted bins. Expected outcome: lower RULA/REBA upper-arm scores.
Torso rotation During handling	Goal: reduce repeated twisting during lifting or placing. Control: Use a turntable or rotate the container instead of the worker's trunk. Expected outcome: lower trunk adjustment scores.
Wrist deviation during weighing and mixing	Goal: maintain wrist-neutral handling. Control: Use smaller tilt bins, handles, or scoops with a neutral grip orientation. expected outcome: lower wrist and wrist-twist scores.
Coupling and container edges	Goal: improve hand contact and reduce grip force. Control: add handholds, rounded edges, or stable handles. Expected outcome: improve REBA coupling and reduce handling strain.

Source: Data processing results

Explaining action into engineering changes makes the assessment actionable for Plant Management of Firm A. For the collecting and weighing tasks, the proposed changes are estimated to reduce the RULA and REBA scores from the medium-risk band to the low-risk band; for the mixing task, the proposed change is estimated to reduce the RULA from Level 2 to Level 1.

4.2.3. Methodological Sensitivity and Complementary Use of RULA and REBA

RULA is beneficial for detecting issues related to upper-limb, wrist, neck, and arm elevation during weighing and mixing activities. REBA is effective in assessing workers' overall body risk, especially when the focus is on trunk flexion, leg support, load handling, coupling, and activity modifiers. When tasks involve substantial upper-limb loading, wrist deviation, or arm elevation, RULA is the more suitable and sensitive tool. In contrast, REBA is better suited to tasks involving whole-body postures, trunk flexion, leg support, unstable movements, or heavier loads.

For instance, in the mixing task, relying solely on a REBA assessment would have downplayed the risk, potentially creating a false sense of safety and overlooking chances for intervention. On the other hand, using only a RULA assessment during the collection task could have overlooked whole-body risks, missing the opportunity to identify necessary ergonomic improvements to alleviate trunk strain and enhance grip conditions.

These results are consistent with the findings of (Sirikasemsuk et al., 2024) who reported that RULA and REBA scores can differ significantly for the same task due to variations in scoring methods and weighting systems. This study builds on that understanding by showing how these differences manifest in an upstream automotive manufacturing firm, where workers perform repetitive tasks requiring different upper-limb and whole-body efforts It is also worth noting that research findings by (Zhu et al., 2026) address the limitations of a rigid zero-tolerance policy by establishing reliable adjustment factors for both the REBA and the RULA. It refines a basic framework and increases the precision of risk evaluations in real world scenarios.

5. Conclusion

This study assessed three representative postures in the mixer section: collecting, weighing, and mixing materials. Collecting materials yielded RULA and REBA scores of 4 and 5, respectively, indicating the need for further investigation and changes. Weighing materials resulted in RULA and REBA scores of 5 and 4, respectively, indicating that corrective action should be considered soon, particularly regarding neck and upper-limb postures and asymmetrical loading. In contrast, REBA classified the posture as negligible risk.

The comparative application of RULA and REBA in the disc-pad mixer section provides three key insights. First, RULA is more sensitive to upper-limb and wrist postures, while REBA better captures whole-body risk associated with trunk flexion and leg loading. Second, the discrepancy observed in the mixing activity underscores the importance of using both methods in a complementary manner. Third, the identified posture risk factors for collecting, weighing, wrist deviation, and mixing are linked to the proposed redesign recommendations, which target these specific drivers to reduce the associated risks.

RULA and REBA should be used as complementary screening tools. RULA is useful for identifying upper-limb, wrist, neck, and arm elevation issues during weighing and mixing. REBA is useful for identifying entire body risk, particularly when trunk flexion, leg support, load, coupling, and activity modifiers are prominent.

The recommended improvements are to adjust the material height and horizontal reach, redesign the container coupling, and reduce trunk rotation to support wrist-neutral handling. These controls should be tested in a future intervention study with pre- and post-implementation RULA and REBA scores, as well as worker feedback.

This study has four main limitations, which should be acknowledged when interpreting the findings. First, the study involved only three operators, although they represented the entire population of the mixing section under study. While the census sampling approach ensured that all available operators were included, the findings are specific to the observed workstation. They may not be representative of other disc-pad manufacturing facilities or upstream automotive plants with different layouts, workloads, or task designs. The reported scores should be interpreted as indicative of risk within this specific context rather than as universally applicable benchmarks.

Second, the analysis was based on selected posture snapshots and did not quantify between-day variability or changes in posture across the work shift. Posture assessment was based on still images captured during normal production activities that represent the most extreme postures observed during the work cycle. Future research should include repeated observations across multiple days and shifts to better characterize postural variability and its impact on risk scores.

Third, the available records did not include inter-rater reliability and direct measurement of all handled masses. Joint angles were measured manually with an angle-measuring tool, which may introduce measurement error. Inter-rater reliability was not formally assessed, although measurements were performed repeatedly to maintain consistency. The handled masses were estimated from observations rather than direct weighing. Future research should include inter-rater reliability testing and direct measurement of loads to improve the accuracy and reproducibility of the risk assessment.

Fourth, the study did not implement a redesign, and the findings served as evidence for risk assessment and guidance for future redesign. Future research should include a post-redesign reassessment to evaluate the effectiveness of the proposed interventions and to quantify the actual reduction in ergonomic risk. However, the methodological approach and the patterns of RULA and REBA differences observed in this study may inform similar assessments in comparable manual-material-handling workstations within the automotive sector.

Future research should include multiple work periods, repeated observations across shifts, and post-redesign reassessment. Additional ergonomic factors, including physiological workload, environmental conditions, and production scheduling, should be incorporated to provide a comprehensive occupational health and safety evaluation.

References

Aliaga, Y., & Beatriz Quispe. (2024). Ergonomic Risk Factors in industries: a systematic review 2018 – 2023. *22nd LACCEI International Multi-Conference for Engineering, Education, and Technology*, 1–9. https://doi.org/10.18687/LACCEI2024.1.1.1035

Aliaga, Y., & Quispe, B. (2024). Ergonomic Risk Factors in industries: a systematic review 2018-2023. *Proceedings of the LACCEI International Multi-Conference for Engineering, Education and Technology*, 1–9. https://doi.org/10.18687/LACCEI2024.1.1.1035 Ergonomic

Aslan, I., Hamitoglu, F., Acar, M., & Acar, H. (2025). Risk Assessment of Ergonomic Factors in a Textile Firm by RULA, REBA and Fine Kinney Methods. *Ergonomics International Journal*, *9*(1), 1–18. https://doi.org/10.23880/eoij-16000340

Ayik Pusakanongwati, Achmad Misbah, & Muhammad Hermansyah. (2022). Design of Soybean Dregs Separator Tool for Tempe Production in MSMEs Pasuruan Regency Using Pulse Method and Rula Method. *JKIE (Journal Knowledge Industrial Engineering)*, *9*(3), 180–191. https://doi.org/10.35891/jkie.v9i3.3505

Bhandare, R. V., Thakur, M. K., Sonawane, G. P., Rayjade, G. R., & Bhagure, A. D. (2025). Human-centered Design and Musculoskeletal Risk Evaluation for All-terrain Hybrid Electric Vehicle: A RULA and REBA Approach. *Evergreen*, *12*(1), 516–525. https://doi.org/10.5109/7342471

Celal Gungor, & Mustafa Fikret Oguz. (2024). Manual material handling risk assessment in furniture industry: REBA method. *World Journal of Advanced Research and Reviews*, *21*(3), 1760–1765. https://doi.org/10.30574/wjarr.2024.21.3.0934

Dhonny, M. A., & Mahbubah, N. A. (2025). Evaluasi Risiko Cedera Musculosceletal Berbasis Metode Rula Dan Reba Pada Operator Bagian Pengiriman Barang Di Pt Dcf. *Sigma Teknika*, *8*(2), 237–249. https://doi.org/10.33373/sigmateknika.v8i2.8497

Fauza Dwi Prirasetyo, A., & Mahbubah, N. (2021). Analisis Postur Pekerja Pada Proses Produksi Tahu Berdasarkan Metode Rapid Entire Body Assessment Di CV Lahan Faedah. *Jurnal Teknologi*, *14*(1), 72–82. https://doi.org/10.34151/jurtek.v14i1.3548

Ferdiansyah, D. A., & Mahbubah, N. A. (2022). Evaluasi Postur Kerja Operator Packing Berbasis Pendekatan Rapid Entire Body Assesment Di Ud. Xeviproduction. *Sigma Teknika*, *5*(1), 047–056. https://doi.org/10.33373/sigmateknika.v5i1.4208

Hedge, A. (1993). *RULA Employee Assessment Worksheet*. https://ergo-plus.com/wp-content/uploads/RULA.pdf

Hedge, A. (2008). *REBA Employee Assessment Worksheet*. https://ergo-plus.com/wp-content/uploads/REBA.pdf

Hignett, S., M. (2000). REBA Employee Assessment Worksheet. In *Applied ergonomics* (Vol. 31, Issue 816).

Hignett, S., & McAtamney, L. (2000). Rapid Entire Body Assessment (REBA). *Applied Ergonomics*, *31*, 201–205. https://doi.org/https://doi.org/10.1016/S0003-6870(99)00039-3

Hita-Gutiérrez, M., Gómez-Galán, M., Díaz-Pérez, M., & Callejón-Ferre, Á.-J. (2020). An Overview of REBA Method Applications in the World. *International Journal of Environmental Research and Public Health*, *17*, 1–22. https://doi.org/https://doi.org/10.3390/ijerph17082635

Imran Aslan, Hamitoğlu F, Acar MN, & Acar HA. (2025). Risk Assessment of Ergonomic Factors in a Textile Firm by RULA, REBA and Fine Kinney Methods. *Ergonomics International Journal*, *9*(1), 1–18. https://doi.org/10.23880/eoij-16000340

Jamshidian, A., Shahjavan, Y., Jelokhani, A. N., Hosseini, S. N., & Arjmand, N. (2024). Musculoskeletal Disorders Risk Assessment Using Various Biomechanical and Ergonomics-Based Tools in an Automobile Fuel Tank Installation Workstation. *2024 31st National and 9th International Iranian Conference on Biomedical Engineering, ICBME 2024*, 77–84. https://doi.org/10.1109/ICBME64381.2024.10895481

McAtamney, L., & Nigel Corlett, E. (1993). RULA: a survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics*, *24*(2), 91–99. https://doi.org/10.1016/0003-6870(93)90080-S

Nur 'ainiyah, Y., Said, S., Dahda, & Jufriyanto, M. (2022). Analisis Terjadinya Risiko Musculoskeletal Disorders Karyawan Bagian Finishing Menggunakan Metode Reba (Studi Kasus : UD Arryna Raya). *Jurnal Sains, Teknologi Dan Industri*, *19*(2), 373–382. https://doi.org/http://dx.doi.org/10.24014/sitekin.v19i2.17912

Prasetyo, N. R. W., Dwiastuti, A., Nurdiansyah, R., Muid, A., Alhafidh, M. N., Nida, R. S., & Fitri, Z. A. (2026). ERGONOMIC RISK LEVEL ANALYSIS USING NORDIC BODY MAP (NBM), RULA, AND REBA METHODS ON MURYA 2 COLLECTION TAILORS. *Multidsciplinary Output Research For Actual International Issue (MORFAI Journal)*, *6*(4), 5955–5962. https://doi.org/https://doi.org/10.5281/zenodo.20933631

Purwanto, P., Widyaingrum, D., Hakim, M. N., & Qulub, M. T. (2026). Proposed Integraed Assesment of RULA, REBA, and OWAS For Ergonomic Risk Evaluation and Workstation Improvement. *Andalasian International Journal of Applied Science, Engineering and Technology*, *06*(02), 182–191. https://doi.org/https://doi.org/10.25077/aijaset.v6i2.337

Rahman, M. N. A., Yek, L. Z., Haw, H. F., Masood, I., Abdullah, H., Hassan, M. F., Haq, R. H. A., Arifin, A. M. T., Osman, S. A., Taib, I., & Pratiwi, I. (2025). Relationship between Improper Working Posture among Maintenance Workers using Different Assessment Methods. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *49*(2), 15–25. https://doi.org/https://doi.org/10.37934/araset.49.2.1525

Sirikasemsuk, K., Kittipanya-Ngam, P., Luanwiset, D., & Leerojanaprapa, K. (2024). Work posture risk comparison of RULA and REBA based on measures of assessment-score variability: A case study of the metal coating industry in Thailand. *International Journal of Innovative Research and Scientific Studies*, *7*(3), 926–935. https://doi.org/10.53894/ijirss.v7i3.2978

Sudiarto, A. D., Khofiyah, N. A., & Feriaty, S. R. (2025). Design of Work Aid Tools To Improve Man Power Work Posture Using Rula Method (Rapid Upper Limb Assessment) Pt.Xyz. *JKIE (Journal Knowledge Industrial Engineering)*, *12*(1), 53–69. https://doi.org/10.35891/jkie.v12i1.6043

Varghese, A., Panicker, V. V., & George, J. (2025). Posture Assessment of Rubber Tappers: A Comparative Analysis of OWAS, REBA, RULA, and PERA Methods. *Medicina Del Lavoro*, *116*(3). https://doi.org/10.23749/mdl.v116i3.15875

Zhu, J., Li, Y., Lewicke, J., & Li, X. (2026). Improvements for adjustment factors of REBA and RULA based on Muscle Activation Analysis of body segmental movement. *International Journal of Industrial Ergonomics*, *114*, 14. https://doi.org/https://doi.org/10.1016/j.ergon.2026.103944