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Proposed Integrated Assessment of RULA, REBA, and OWAS for Ergonomic Risk Evaluation and Workstation Improvement

Purwanto[1*], Dzakiyah Widya Ningrum[1,2] , Muhammad Naufal Hakim[1], Muhamad Tatmainul Qulub[1]
[1]Teknik Industri, Fakultas Teknik, Universitas Muhammadiyah Gresik, Indonesia
[2]Industrial Engineering, Khon Khaen University, Thailand
[*]Corresponding author, email: purwanto@umg.ac.id

Abstract— Manual work with non-ergonomic postures significantly contributes to musculoskeletal disorders (MSDs), affecting worker health and productivity. This study analyzed ergonomic risks at a production workstation using the Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), and Ovako Working Posture Analysis System (OWAS) methods. A descriptive quantitative approach was applied to seven operators. The results showed that 28.6% of operators were categorized as high risk, 28.6% as moderate risk, and 42.8% as low risk. High-risk postures were associated with upper arm flexion above 60°, trunk bending, non-neutral wrist positions, and manual material handling activities. OWAS analysis identified two operators in action class 3, indicating that corrective actions are needed soon. Ergonomic improvement simulations, including worktable height adjustment, material repositioning, and assistive device use, reduced RULA scores by 40–50%, REBA scores by 35–45%, and OWAS action class from 3 to 2. The study concludes that integrating RULA, REBA, and OWAS provides a comprehensive ergonomic risk assessment and supports effective interventions to reduce MSD risks, improve worker comfort, and enhance productivity.

Keywords: ergonomics_1, working posture_2, RULA, REBA_3, OWAS_4, MSDs_5, productivity_6.

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1. Introduction

Increasingly intense global competition is driving industry to continuously improve productivity, operational efficiency, and product quality to maintain competitiveness in the international market. Technological transformation is developing rapidly, but in reality, most production processes in various sectors, particularly small and medium-scale manufacturing industries, still rely heavily on manual work activities. This condition places the human factor as a key component in the production system, both as the main implementer and as a controller of process quality. Various recent studies confirm that the performance of production systems is greatly influenced by the match between job demands and the physical and cognitive capacities of workers, making ergonomic aspects a strategic factor in designing modern work systems [1],[2],[3]. Manual work generally involves lifting, pushing, pulling, reaching, bending, and performing repetitive movements for long durations. If these activities are performed with non-ergonomic postures, it will increase the biomechanical load on the musculoskeletal system, particularly on the spine, shoulders, neck, and upper extremities. Biomechanical loads that exceed the adaptive capacity of body tissues can trigger musculoskeletal disorders (MSDs), which are characterized by complaints of pain, stiffness, and decreased motor function. Recent epidemiological studies have shown that workers with exposure to non-neutral postures have a 1.5–2.5 times higher risk of MSDs than workers with ergonomic working postures [4],[5],[6].

At the global level, the International Labour Organization (ILO) reports that more than one-third of occupational diseases are related to musculoskeletal disorders, making them one of the most dominant

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occupational health problems worldwide. The economic burden of MSDs is also significant, including medical costs, workers' compensation, and lost work hours due to absenteeism and reduced work capacity. Recent reports and research indicate that companies with a high prevalence of MSDs tend to experience a 10–20% decrease in productivity compared to companies that consistently implement ergonomic work systems [7],[8],[9]. These findings confirm that MSDs are not only a health issue, but also a strategic issue that affects organizational performance. Ergonomics as a scientific discipline focuses on adapting jobs, equipment, and the work environment to human characteristics and limitations. Modern ergonomic approaches aim not only to prevent injuries but also to optimize system performance by increasing human comfort, efficiency, and reliability at work. Several experimental studies have shown that ergonomic interventions based on improved posture and workstation design can reduce MSD complaints by 30–60% and increase productivity by 10–25% [10],[11],[12]. Therefore, the implementation of ergonomics can be viewed as a long-term strategic investment for industry. A crucial initial step in implementing ergonomics is conducting a systematic evaluation of work posture. Observational methods are widely used because they are relatively easy to implement, do not require expensive equipment, and can provide a quick overview of the level of ergonomic risk. The Rapid Upper Limb Assessment (RULA) was developed to assess the risk of MSDs in the upper extremities by considering the posture of the arms, wrists, neck, and trunk. The Rapid Entire Body Assessment (REBA) is designed to evaluate whole-body posture, particularly in dynamic and unstructured work. Meanwhile, the Ovako Working Posture Analysis System (OWAS) classifies work postures based on the combination of the position of the back, arms, legs, and the load handled by the worker [12],[13].

The use of a single method in research is often unable to describe the complexity of work posture risks in their entirety. Several studies have shown that the combination of RULA, REBA, and OWAS provides a better level of sensitivity and accuracy in identifying body parts with high potential risks and workstation improvement priorities [13], [15]. This multi-method approach allows researchers to gain a more comprehensive perspective on actual ergonomic conditions in the field. Based on this background, this study aims to analyze the level of work posture risk using the RULA, REBA, and OWAS methods in an integrated manner and to develop applicable work position improvement proposals. It is hoped that the research results can contribute to reducing the risk of MSDs, increasing work comfort, and having a positive impact on worker productivity and quality of production processes.

2. Method

2.1 Research Design and Type

This research falls into the applied research category with a descriptive quantitative approach. The aim is to identify the level of ergonomic risk in operator work postures and formulate proposals for improving work positions based on objective measurement results. Applied research focuses on solving practical problems in the field through the application of validated scientific concepts and methods, so that the results can be directly utilized by industry as a basis for decision-making to improve work systems [1], [14]. A descriptive quantitative approach was used because this study produces numerical data in the form of RULA, REBA, and OWAS scores that describe the level of ergonomic risk in each work posture. This approach is commonly used in ergonomic studies to map actual conditions, determine the urgency of improvement, and compare conditions before and after intervention [13], [15].

2.2 Research Location and Time

The research was conducted at a production workstation characterized by manual work, with dominant activities including standing, bending, reaching, and moving materials. The workstation was selected based on the consideration that it is a critical point in the production process and has a high intensity of physical activity. Data collection was conducted over one consecutive workweek to ensure that the observed postures represent normal working conditions and to reduce bias due to daily activity variations. Previous studies suggest that an observation period of at least several days is necessary to increase the reliability of ergonomic data [8].

2.3 Research Subjects

The research subjects consisted of seven operators selected using purposive sampling, which selects respondents based on specific criteria relevant to the research objectives. These criteria include:

a. Operators directly involved in the observed workstations.
b. Have at least one year of work experience.
c. Perform primary work activities regularly.

The use of purposive sampling is common in case study-based ergonomics research, as the primary focus is to obtain an in-depth understanding of postural risks in specific jobs, rather than generalizing to a broad population [16]. Ergonomic Risk Analysis Method

2.4 Rapid Upper Limb Assessment (RULA)

RULA is used to evaluate the risk of MSDs in the upper extremities by considering the posture of the upper arm, forearm, wrist, neck, and trunk, as well as load and activity factors. The final RULA score is classified as:

a. Score 1–2: Low risk (no action required)
b. Score 3–4: Moderate risk (further investigation required)
c. Score 5–6: High risk (immediate changes required)
d. Score 7: Very high risk (immediate action required)

This method has proven sensitive in identifying risks in jobs involving intensive hand activity [12].

2.5 Rapid Entire Body Assessment (REBA)

REBA evaluates the posture of the entire body, including the neck, trunk, legs, and upper extremities. The final score is classified as very low to very high risk. REBA is suitable for use in dynamic and unstructured jobs [13].

2.6 Ovako Working Posture Analysis System (OWAS)

OWAS classifies posture based on the combination of back, arm, and leg positions, and workload into four action classes:

a. Class 1: No action required
b. Class 2: Needs future improvement
c. Class 3: Needs immediate improvement
d. Class 4: Needs immediate improvement

This method is effective for rapidly mapping work postures in industrial settings [14].

2.7 Data Analysis and Method Integration

RULA, REBA, and OWAS scores were analyzed descriptively and comparatively to:

a. Identify postures with the highest risk.
b. Determine body parts most exposed to risk.
c. Establish improvement priorities.

A multi-method approach was used because the combination of several assessment tools has been shown to increase the reliability of results and provide a more comprehensive picture of risk than using a single method alone [15], [16], [17].

2.8 Simulation and Evaluation of Proposed Improvements

Based on the analysis results, simulations of ergonomic improvements were conducted, including:

a. Adjusting the work desk height based on the worker's anthropometry.
b. Change the material's position to ensure it is within the optimal reach zone.
c. Addition or use of work aids.

The simulated work postures are then re-evaluated using RULA, REBA, and OWAS to obtain an estimated risk score reduction. The score reduction is used as an indicator of the effectiveness of the proposed improvements [11].

3. Result and Discussion

This study aims to analyze the risk level of work postures in operators using the RULA, REBA, and OWAS methods in an integrated manner and to prove the potential effectiveness of proposed ergonomic improvements. The results showed that more than half of the operators were at moderate to high risk levels, which indicates that work activities at the observed production stations were still not fully aligned with ergonomic principles. This finding confirms that manual work involving standing, reaching, bending, and moving materials repeatedly has a significant potential to cause excessive biomechanical loads on the musculoskeletal system.

3.1 Interpretation of RULA Analysis Results

The RULA analysis results showed that two of the seven respondents (25.6%) were in the high-risk category (score 6–7), two respondents (28.6%) were in the moderate-risk category (score 3–4), and three respondents (42.8%) were in the low-risk category (score 1–2). This distribution indicates that although some work postures are relatively safe, a significant proportion of workers are still exposed to high levels of ergonomic risk that require immediate remedial action. High RULA scores are primarily influenced by upper arm positions with a flexion angle greater than 60°, trunk flexion, and non-neutral wrist positions. Biomechanically, excessive upper arm flexion increases the moment of force on the shoulder joint and causes increased activity of the deltoid and trapezius muscles, thus accelerating muscle fatigue. Furthermore, deviated wrist positions or excessive flexion-extension are associated with increased pressure on the carpal tunnel and surrounding soft tissues. These findings align with those of Chen (2022) and Wong (2023) [4],[5], who reported that non-neutral upper extremity posture was a strong predictor of shoulder and wrist pain in manufacturing workers. The predominance of low scores among respondents indicates that some work activities are within ergonomic tolerance limits. However, the presence of respondents with high scores confirms the inconsistency of workstation design with ergonomic principles, necessitating standardization and improvement.

Table 1. RULA Scores and Operator Risk Categories

Operator	Skor RULA	Kategori Risiko
O1	7	Tall
O2	6	Tall
O3	4	Currently
O4	3	Currently
O5	2	Low
O6	2	Low
O7	1	Low

The results of the RULA analysis in Table 1 show that two of the seven respondents (25.6%) were in the high-risk category (score 6–7), two respondents (28.6%) were in the moderate risk category (score 3–4), and three respondents (42.8%) were in the low risk category (score 1–2). This distribution indicates that although some work postures are relatively safe, a significant proportion of workers are still exposed to high levels of ergonomic risk that require immediate corrective action. High scores on the RULA are primarily influenced by upper arm positions with a flexion angle of more than 60°, trunk flexion, and wrist positions that are not in a neutral position. Biomechanically, large upper arm flexion increases the moment of force on the shoulder joint and causes increased activity of the deltoid and trapezius muscles, thereby accelerating muscle fatigue. In addition, deviated wrist positions or excessive flexion-extension are associated with increased pressure on the carpal tunnel and surrounding soft tissues. These findings align with those of Chen (2022) and Wong (2023), who reported that non-neutral upper extremity posture was a strong predictor of shoulder and wrist pain in manufacturing workers. The predominance of low scores among some respondents indicates that some work activities are within ergonomic tolerance limits. However, the presence of respondents with high scores highlights the inconsistency of workstation design with ergonomic principles, necessitating standardization and improvement.

3.2 Interpretation of REBA Analysis Results

REBA's high sensitivity to whole-body posture makes it an effective method for identifying risks in jobs involving coordination between the trunk, upper extremities, and lower extremities.

Table 2. REBA Scores and Operator Risk Categories

Operator	Skor REBA	Kategori Risiko
O1	10	Tall
O2	9	Tall
O3	7	Currently
O4	6	Currently
O5	4	Low
O6	3	Low
O7	2	Low

The results of the REBA analysis in Table 2 show that two respondents were at high risk (scores 9–11), two respondents were at moderate risk (scores 5–7), and three respondents were at low risk (scores 2–4). This distribution pattern is relatively consistent with the results of RULA, indicating consistency between methods in identifying individuals at highest risk. The dominant factors causing high REBA scores are trunk flexion of more than 20°, unstable foot position, and moderate frequency of lifting activities. Repeated or sustained trunk flexion increases compressive stress on the lumbar intervertebral discs and increases the risk of low back pain. Unstable foot position also reduces body balance and increases the need for postural muscle contraction. Recent biomechanical studies have shown that the combination of trunk flexion and lifting activities can increase spinal compressive forces up to twofold compared to the neutral position [8,11,17]. REBA's high sensitivity to whole-body posture makes this method effective in identifying risks in jobs that involve coordination between the trunk, upper extremities, and lower extremities. This strengthens the argument that the use of REBA is very relevant at workstations with complex manual activities.

3.3 Interpretation of OWAS Analysis Results

OWAS classifies postures based on a combination of back, arm, leg and load positions, thus providing a macro picture of the hazard level of work postures.

Table 3. Recapitulation of OWAS Results

Operator	Kelas OWAS	Interpretasi
O1	3	Perlu perbaikan secepatnya
O2	3	Perlu perbaikan secepatnya
O3	2	Perlu perbaikan di masa depan
O4	2	Perlu perbaikan di masa depan
O5	1	Tidak perlu tindakan
O6	1	Tidak perlu tindakan
O7	1	Tidak perlu tindakan

Analysis of the OWAS results in Table 3 shows that two respondents were in action class 3, two respondents in action class 2, and three respondents in action class 1. Action class 3 indicates that the work posture has the potential to cause musculoskeletal disorders and requires immediate improvement. OWAS classifies postures based on the combination of back, arm, leg, and load positions, thus providing a macro picture of the level of danger of work postures. The findings of two respondents in action class 3 confirm the results of RULA and REBA that there are postures that simultaneously involve a hunched back, raised arms, and a certain workload. Karhu 2022 stated that the agreement of OWAS results with other observational methods indicates good validity in mapping ergonomic risks in industrial environments.

3.4 Ergonomic Improvement Simulation Evaluation

The results of the improvement simulation indicate that all respondents previously in the high-risk category are projected to move down to the moderate category. The average decrease in RULA scores of 40–50% and REBA scores of 35–45%, as well as the change in OWAS action class from class 3 to class 2, indicate that the proposed improvements have high potential for effectiveness.

The decrease in scores was primarily due to:

1. Adjusting the workbench height to reduce torso flexion.

2. Relocating materials to the optimal reach zone to reduce the angle of arm elevation.

3. Using assistive devices to reduce the need for bending and lifting.

These findings are consistent with those of Robertson (2021) and Zare (2022), who reported that interventions based on workstation design and material rearrangement were able to reduce RULA and REBA scores by 30–60%.

The consistency of the results between RULA, REBA, and OWAS indicates that the integration of the three methods provides a more comprehensive picture of ergonomic risk than using one method alone. RULA is sensitive to the upper body, REBA to the whole body, and OWAS to macro posture classification, so the combination of the three is complementary. This is in line with Rahman (2024) and Habibi (2023), who emphasized that a multi-method approach increases the reliability of risk identification and accuracy in determining improvement priorities. Overall, the results of this study strengthen the concept that unergonomic work postures are correlated with a high risk of MSDs and demonstrate that simple but targeted ergonomic interventions can have a significant impact on risk reduction.

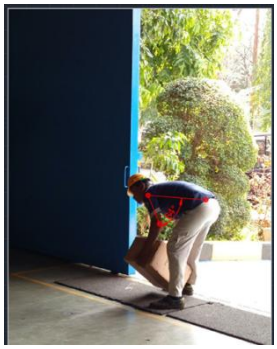

Figure 3.1 worker activities



Figure 3.2 workers organize products

Figure 3.1 shows the head is bent at an angle of 75°, so it is an angle of more than 20°. Therefore, the neck gets a score of 3 and there is an additional score due to the position of the neck tilting to the side or rotating. Figure 3.2 shows the head is bent at an angle of 55°, so it is an angle of more than 20°. Therefore the neck gets a score of 3.

3.5 Discussion

The results of the study indicate that work activities at the observed production stations still contain significant ergonomic risks. Based on analysis using the RULA, REBA, and OWAS methods, more than half of the operators were in the moderate to high risk category, indicating a mismatch between job demands and the workers' biomechanical capacities. This situation demonstrates that manual work involving standing, reaching, bending, and repetitive material handling remains a major source of exposure to the risk of musculoskeletal disorders (MSDs). This finding aligns with ergonomic theory, which states that non-neutral postures maintained for prolonged durations can increase the mechanical load on musculoskeletal tissue and accelerate muscle fatigue and tissue microtrauma.

The RULA analysis findings indicate that 28.6% of operators were in the high risk category, primarily influenced by upper arm flexion exceeding 60°, trunk flexion, and non-neutral wrist positions. Biomechanically, this combination of postures increases the moment of force on the shoulder joint and spine and increases static muscle activity, potentially leading to pain in the shoulders, neck, and wrists. Meanwhile, the REBA results showed a pattern consistent with RULA, with 28.6% of operators also in the high-risk category. The dominant factors in REBA included trunk flexion, unstable foot position, and lifting activities. This indicates that ergonomic problems are not limited to the upper extremities, but also involve the trunk and lower extremities. Repeated trunk flexion is known to increase compressive stress in the lumbar segment, which is strongly correlated with the occurrence of low back pain.

The OWAS results reinforced the RULA and REBA results, with 28.6% of operators found in class 3, requiring immediate correction. The agreement between the methods demonstrated consistency in identifying problematic postures and confirmed that the overall work posture configuration—including the back, arms, legs, and load—contributes to high ergonomic risks. The integration of these three methods provides a more comprehensive picture than using a single method alone, as each method is sensitive to different body segments.

4. Conclusion

This study demonstrates that work activities at the observed stations still contain significant ergonomic risks, as indicated by the identification of operators in the moderate to high risk categories based on the RULA, REBA, and OWAS methods. This condition indicates a mismatch between job

demands and workers' biomechanical abilities, particularly regarding torso flexion angle, arm elevation, wrist position, and manual load involvement. Implementing proposed ergonomic improvements, including adjusting workstation dimensions, relocating materials to optimal reach zones, using assistive devices, and educating about work postures, proved effective in quantitatively reducing risk levels. The average RULA score decreased by 43.9% and the average REBA score decreased by 41.5%. No operators were found in the high-risk category in the post-test. Furthermore, all operators previously in action class 3 based on OWAS moved to action class 2 or 1, indicating that work postures no longer required immediate corrective action. The consistency of the results across the three methods demonstrates that the integrated ergonomic evaluation approach is capable of providing a comprehensive and reliable picture of risks. These findings confirm that simple, relatively low-cost ergonomic interventions can have a substantial impact on reducing the risk of musculoskeletal disorders. Practically, the results of this study can serve as a basis for industry to prioritize risk-based workstation improvements. Academically, this study strengthens empirical evidence regarding the effectiveness of the combination of RULA, REBA, and OWAS in evaluating and designing ergonomic interventions. However, further research is recommended to involve a larger number of respondents, implement the interventions in real-world settings, and evaluate their impact on musculoskeletal disorders and long-term productivity.

Practical Implications

The results of this study provide strong practical implications for industrial management in efforts to improve occupational health and production system performance. (a) First, the finding that more than half of operators are at moderate to high risk levels demonstrates the need for a systematic implementation of ergonomics programs, starting with routine work posture evaluations using observational methods such as RULA, REBA, and OWAS. This approach enables companies to identify critical work posture points and prioritize data-driven improvements. (b) Second, the results of improvement simulations indicate that simple interventions such as adjusting workbench heights, repositioning materials, and using assistive devices can significantly reduce risk scores. This indicates that improving ergonomic conditions does not always require large investments, but rather emphasizes workstation design that aligns with anthropometric and biomechanical principles. (c) Third, the implementation of the proposed ergonomic improvements has the potential to have a dual impact, reducing the risk of musculoskeletal disorders while increasing work comfort and efficiency. By reducing fatigue and physical complaints, operators are expected to maintain consistent performance, thereby sustainably increasing productivity and output quality. Therefore, the results of this study can serve as a basis for developing internal company ergonomics policies.

Recommendations

This study has several limitations that should be considered when interpreting the results. (a) First, the number of study subjects was relatively limited and only covered one workstation, so generalizing the results to the entire production process or to other industries requires caution. (b) Second, this study used an observational method, which, while practical and efficient, still carries the potential for subjectivity in posture assessment, particularly in determining body segment angles. Despite the assistance of visual documentation and digital measuring tools, there is still potential for variation in assessments between assessors. (c) Third, the evaluation of the effectiveness of ergonomic improvements is still simulated, and therefore does not reflect actual implementation conditions in the field over a specific period. Therefore, the actual impact on reducing MSD complaints and increasing productivity cannot be directly measured.

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