



## **Application of *Participatory Ergonomic* Method to Reduce *Musculoskeletal Disorders With Rapid Whole Body Assessment (REBA)* at PT. Adyawinsa Stamping Industries**

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**Abstract.** PT. Adyawinsa Stamping Industry is one of the automotive companies in Karawang, West Java. In the production process, most of the work has poor posture, which can cause Vascular Disorders (MSDs). In the process of eliminating and reducing the risk of MSDs in the workplace, the level of MSD risk experienced by workers is calculated using the REBA method. The results of the REBA calculation obtained several activities with values above 9 (meaning that an improvement is needed). To improve the work system using the Participatory ergonomic (PE) method involving the operator, management and ergonomics. The results of the application of PE in helping to reduce the risk level of MSDs are engineering (making auxiliary tools and also management engineering) that can improve the work posture used, namely using the REBA method. Based on the results of the REBA calculation after the improvement, the risk generated is a risk level smaller than the previous posture, namely medium and low. Real improvements are hoped to create a safe, comfortable, and productive workplace.

**Keywords:** work posture, REBA, NBM, Occupational safety, Occupational health

### **INTRODUCTION**

The production process in Indonesia's automotive industry still uses a lot of human labor, so it is very vulnerable to various problems related to MSDs. MSDs are diseases related to joints, muscles, bones, ligaments, tendons, and the spine [1], [2]. Workers' MSD disorder causes a decrease in production because workers become unenthusiastic about work, causing complaints of back pain, neck pain, pain in the shoulders, elbows, and legs, and frequent pain [3]. This disorder is closely related to work and has a multifactorial nature; in other words, risk factors can be more than one, so it can worsen the state of the body[4]. MSDs have a huge burden on the organization's finances due to the costs associated with medication and care for workers [5]. In addition, the severe impact on workers who experience MSDs continuously (6 to 12 months) causes permanent illness [6]. This problem

causes stakeholders to carry out ergonomic interventions so workers can carry out their duties properly and correctly

In line with that, a regulation in Law No. 1 of 1970 concerning occupational safety states that every worker has the right to protection for safety in working for the welfare of life and increasing national production and productivity. Research related to the posture of workers when operating angkong was carried out in order to be able to improve the health of the workers' bodies and minimize the occurrence of MSDs complaints. For the measurement methods carried out in the study, *Nordic Body Map* and *Rapid Entire Body Assessment (REBA)* were used.



**Figure 1. Operator's Working Position in the Delivery Section**

In REBA, two parts are discussed. The first part consists of the neck, body, and legs. The second part is the arm and wrist. The assessment is adjusted to the position that has been available. The assessment stage is carried out in 13 steps. After being assessed for each position, the total score obtained is added up. The details of the REBA are seen in Figure 2.

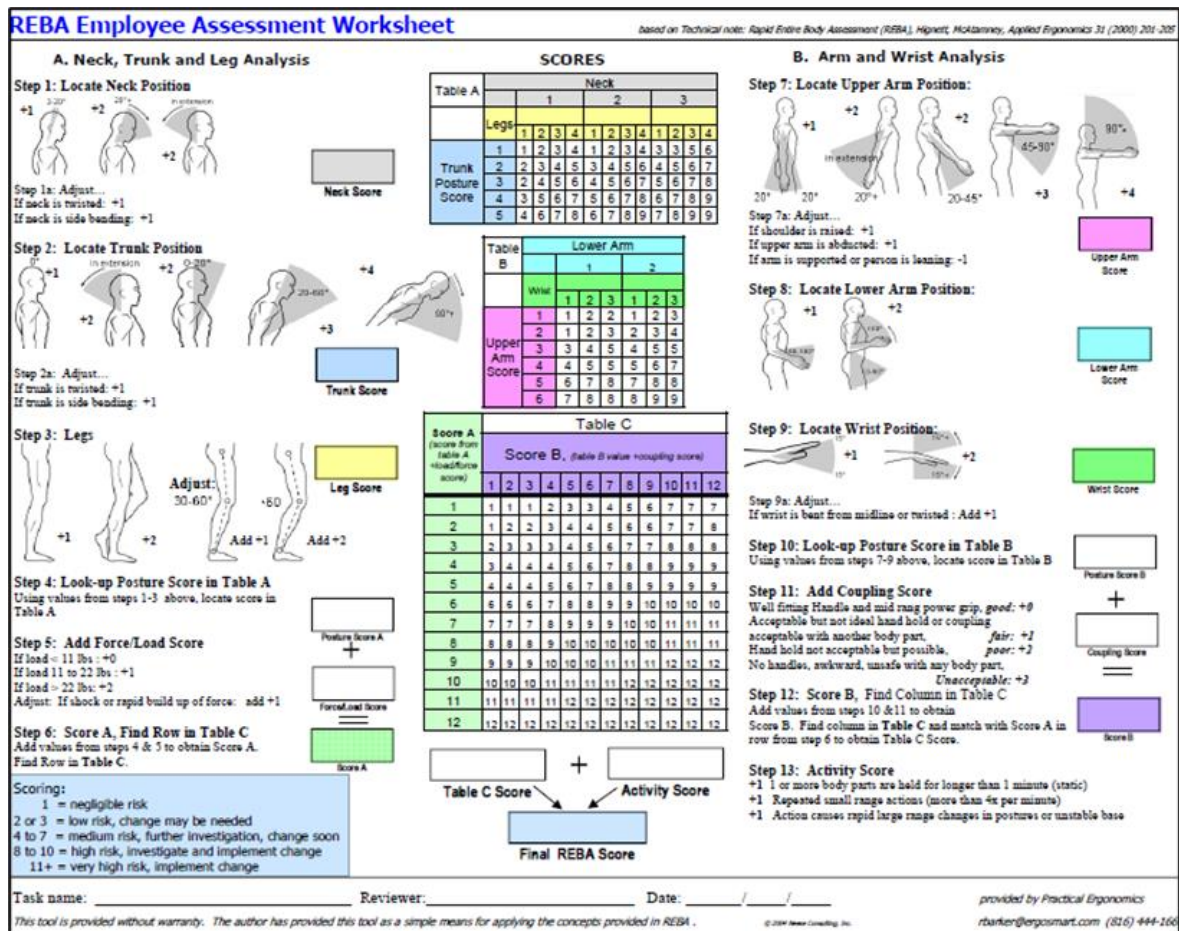


Figure 2. REBA

After the score is obtained in the calculation, the final score is adjusted to the action level table. For example, if the *final score* is 9, the risk level is high, and corrective action must be taken immediately [15].

Table 1. Action Level

REBA Score	Risk Level	Action
1	Ignored	Not Required
2-3	Low	May Be Required
4-7	Keep	Needed
8-10	Tall	<i>Necessary Soon</i>
11-15	Very High	<i>Immediately Necessary</i>

## METHOD

The research was conducted at PT Adyawinsa Stamping Industries (ASI) Jl. Surotokunto No.109, East Karawang, West Java. REBA measurement on selected workers. Their posture is carefully measured before measurements are taken on selected workers in the *Stamping* and *Welding* sections. Next, REBA measurements and the MSDS risk level were measured. The results of this measurement are grouped into three groups based on the acquisition of REBA scores: high, medium, and low. For high groups, improvements will be made to the work system. There is no need for the medium and low groups to make improvements. For groups of workers with *high-risk levels*, ergonomic interventions will be carried out by making assistive devices so that they are expected to get a safe value (below the threshold). To make the right improvements, it is necessary to discuss with stakeholders (operators, companies, and ergonomics), namely with the *Participatory Ergonomics Method* [7], [8]. The roles of each party are as follows:

1. The operator is its participation in planning, implementing, and evaluating work improvements. Forms of participation that can be done include *quality circles*, where *participants* interact with each other to make improvements and ultimately provide advantages in terms of quality and reduction in production costs.
2. The company (management) is a group that supports the PE process according to expectations. In this case, the organization is more focused on the group that affects the running of PE, namely the upper and lower-level management. The upper management consists of *the steering committee* and related managers, while the lower management is the supervisor to the foreman. The upper management is more focused on the policies in the PE process, while the lower management focuses on the operational aspect.
3. Ergonomist. An ergonomist is a person who masters in depth the structure of the human body, the power required, ergonomic implications, fatigue and its prevention, the ergonomic relationship between humans and the equipment used, employee satisfaction, and methods for job improvement.

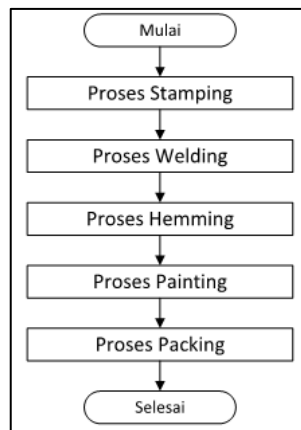
The benefits of implementing PE [9], according are:

1. Work accidents can be reduced if the work design concept is adjusted to the operator's physical condition and ability.
2. Direct or indirect cost savings. These cost savings can occur because the number of work accidents is decreasing.

3. Employee productivity increases because employees carry out the tasks given in accordance with their physical condition and abilities, allowing them to work optimally.
4. Reducing material loss that occurs during production, such as the failure of finished and semi-finished products, due to operators who use tools/machines that are in accordance with their physical conditions and capabilities so that they will produce products with a low error rate.
5. Improving the work environment creates a comfortable workplace, which motivates employees to work long hours.

### RESULTS AND DISCUSSION

The production process in this company can be seen in **Figure 3**.



**Figure 3. Production Process Flow of Stamping Products**

The description of each workstation and the number of respondents taken can be seen in Table 2.

Table 2. Station Description and Number of Respondents Taken at Each Station

Station	Activity	Number of Responses-Den
<i>Material Handling</i>	Moving Goods	4
<i>Stamping</i>	Moving goods from stamping stations	8
	Stamping machine operation	
<i>Welding</i>	Moving goods at a welding station	4
	Operation of welding machine	
<i>Hemming</i>	Moving Goods	4

	Operating the hemming machine	
<i>Painting</i>	Painting Process	3
<i>Painting (Material Handling)</i>	The process of moving goods in the painting section	4
<i>Packing</i>	Pre-packing process	4
	Packaging process with box	
	The process of transferring goods to the cardboard table	

Following the provisions of the calculation of NBM and REBA, each respondent was asked to submit complaints faced during work [10]; [11]; [12]; and [13]. According, the assessment of the NBM questionnaire includes (1) filling out the NBM questionnaire based on body parts and the level of pain felt, (2) weighting based on the level of pain felt by the number of body parts, (3) calculation of the total weight obtained, (4) conversion of the total weight into the level of risk of the work performed. The results of the NBM calculation can be seen in

**Table 3.**

The next stage sorts the pain level from the most miniature score to the most significant score. From the calculation, the five most significant body parts with the highest pain level are obtained, namely the right hand, right knee, hip, waist, and back, with a pain level score of 2-2.9 on a scale of 4.

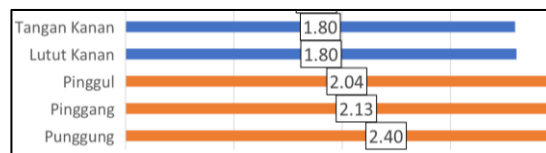


Figure 4. Top 5 body parts by pain level from NBM results

**Table 3. Risk Level Results from the Assessment using the NBM Questionnaire Method**

No.	Station	Activity	NBM Risks
1	<i>Material Handling</i>	Moving Goods	Keep
2	<i>Stamping</i>	Moving goods from <i>stamping stations</i>	Keep
3		Using a <i>stamping machine</i>	
4	<i>Welding</i>	Moving goods at a welding station	Low
5		Using welding machine	

7	<i>Hemming</i>	Moving objects on hemming	Low
8		Operation of the <i>Hemming Machine</i>	
9	<i>Painting</i>	Painting Process	Keep
10		The process of moving goods in the painting section	
11	<i>Packing</i>	Pre-packing <i>process</i>	Low
12		Packaging process with box	
13		The process of transferring goods to the cardboard table	

The next stage is the calculation with the REBA Method using the current provisions [14]; [15] and [16], there are 6 main steps: (1) observing the task, (2) choosing a posture for assessment, (3) assigning a score to the posture, (4) scoring the process, (5) setting the REBA score or *final score* REBA, and (6) convert the REBA value. Figure 5 is an example of a REBA calculation at the station's *Material Handling*.



**Figure 5. Angle of Worker A's Posture on Transferring Goods at the Material Handling Station**

All respondents will carry out the measurement process mentioned in Table 2. The results of the initial posture evaluation for all stations using the REBA and NBM methods can be seen in the Table 5. and

Table 3. . From the calculation results, several jobs require improvement because they have moderate risks (*medium*) to very high (*very high*). Meanwhile, stations with a *negligible* risk until *Low* that is *Welding* and *Hemming* and further do not require repairs. Workstations that require repair can be seen at

**Table 4.**

**Table 4. Selected Jobs Based on the Results of REBA and NBM.**

Station	Activity	Risk REBA	NBM Risks
<i>Material Handling</i>	Moving Goods	<i>High</i>	Keep
<i>Stamping</i>	Moving goods from stamping stations	<i>Very High</i>	Keep
	Using a stamping machine	<i>High</i>	
<i>painting</i>	The process of moving goods in the painting section	<i>Very High</i>	Keep
<i>Packing</i>	Packaging process with box	<i>High</i>	Low
	The process of transferring goods to the cardboard table	<i>Very High</i>	

Table 5 summarizes and displays the results of REBA and NBM measurements. Each activity shows the level of risk that exists; for example, in the activity of moving goods (in *the Material Handling Station*), the results of REBA's calculation are high, and the NMB is medium; likewise, for the following activities.

**Table 5. Recapitulation of REBA Results at All Stations**

No.	Station	Activity	Final Score of Group A	Final Score of Group B	REBA Final Score	Risk	Action
1	<i>Material Handling</i>	Moving Goods	8	3	10	<i>High</i>	Urgently needed
2	<i>Stamping</i>	Moving goods from stamping stations	9	5	12	<i>Very High</i>	Required Now
3		Stamping machine operation	7	4	9	<i>High</i>	Urgently needed
4	<i>Welding</i>	Moving goods at a welding station	1	2	1	<i>negligible</i>	Not Required
5		Operation of welding machine	2	1	2	<i>Low</i>	May Be Required
7	<i>Hemming</i>	Operating the hemming machine	1	2	2	<i>Low</i>	May Be Required

8		Operating the hemming machine	1	2	2	Low	May Be Required
9		Painting Process	1	1	3	Low	May Be Required
10	Painting	The process of moving goods in the painting section	9	3	11	Very High	Required Now
11		Pre-packing process	2	1	3	Low	May Be Required
12	Packing	Packaging process with box	6	4	9	High	Urgently needed
13		The process of transferring goods to the cardboard table	7	5	9	High	Urgently needed
<b>Average</b>			5	3	6	medium	Needed
<b>Max</b>			9	5	12	Very High	Required Now
<b>Min</b>			1	1	1	negligible	Not Required

From the calculations of REBA and NBM, it is necessary to make serious improvements so that operator complaints are reduced [16]. The repair process using the PE Medode was carried out several times. The first is an FGD (focus group discussion) to choose who will represent each of these parties. The second stage sorts out which activities need improvement. The third stage is to create a suitable concept for improvement for the operator and management according to the direction of the ergonomist. From these three stages, improvement proposals for each activity (Tabel 6).

For example, improvements should be made in *the Material Handling* section, especially in moving goods. The standing posture is a standby attitude both physically and mentally so that the work activities carried out are faster, stronger, and more thorough so consideration is needed so that the standing position is good:

1. Workers must hold heavy objects (more than 4.5 kg);
2. Workers often reach up, down, and sideways;
3. Workers often do work by pressing down.

**Table 6.** Proposals Given at Each Station

Station	Activity	Proposal
<i>Material Handling</i>	Moving Goods	Using a <i>Trolley</i> with a height-adjustable anvil
<i>Stamping</i>	Moving goods from stamping stations	Makes mold parts easily reachable
	Using a stamping machine	Using customizable buttons Improved posture used
<i>painting</i>	The process of moving goods in the painting section	Using a vertical trolley of the appropriate height
Packing	Packaging process with box	Posture improvement
	The process of transferring goods to the cardboard table	Improves posture and gives suggestions to be carried by two people

The consensus proposal is to provide an ergonomic trolley such as Figure 6. *The trolley* is designed to have a maximum height on the table, which is from the 95th percentile at the height of the elbow, which is 1097.3 mm or about 1100 cm, with a length *Handle* (50th percentile of elbow height, i.e. 1040 cm).

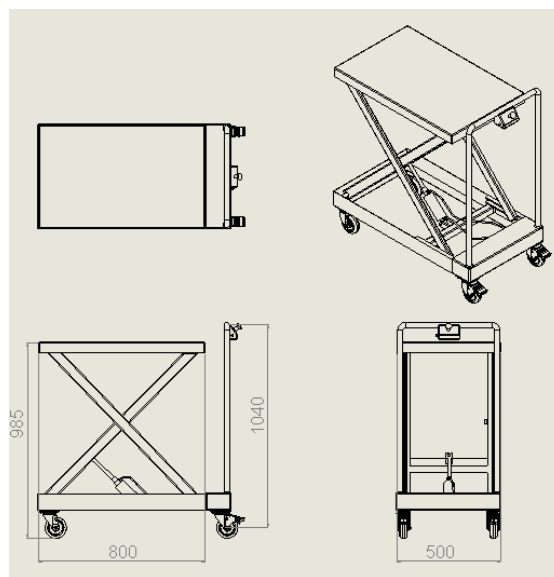
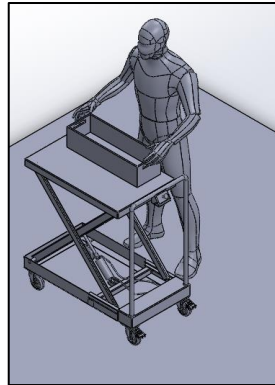


Figure 6. Proposed Trolley Dimensions

This proposal was then simulated using a 3D model (*SOLIDWORKS software*). Figure 7 shows an example of a 3D model simulation of the activity of moving goods.



**Figure 7.** Simulation of Proposed Improvements in Goods Moving Activities at *Material Handling Stations*

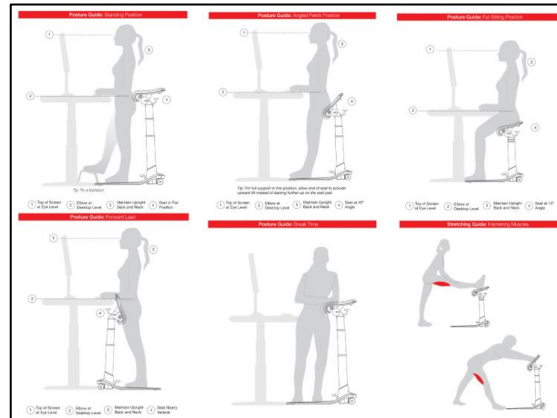
The results of this proposal were then tested again, and the value of the REBA method (Table 7. ).

**Table 7.** Evaluation of Proposed Improvements Given at Each Station with the REBA Method

Station	Activity	RiskREBA Before	RisksREBA After
<i>Material Handling</i>	Moving Goods	<i>Very High</i>	<i>Low</i>
<i>Stamping</i>	Moving goods from stamping stations	<i>Very High</i>	<i>medium</i>
	Using a stamping machine	<i>High</i>	<i>Low</i>
<i>painting</i>	The process of moving goods in the painting section	<i>Very High</i>	<i>medium</i>
<i>Packing</i>	Packaging process with box	<i>High</i>	<i>Low</i>
	The process of transferring goods to the cardboard table	<i>Very High</i>	<i>Low</i>

Table 6 explains that the risk level of work posture becomes better (initially high to moderate).

In addition to improving posture, other improvements include the use of standing chairs that can support the operator when performing activities (Table 6). The sit-stand position is the best and is more desirable than just sitting or standing to reduce muscle fatigue [4].



**Figure 8.** Simulation of Proposed Improvements to the Provision of Standing Chairs  
(Source : Ergoimpact, 2019)

The advantage of this standing chair design is a dynamic attitude that can improve the health of workers, especially work posture,, sit-stand posture in the industry *laundry* can increase productivity by 85%.

## CONCLUSION

The results of the study can be summarized as follows:

1. The results of data processing and observation using the NBM and REBA methods show that activities on the production floor are high risk, except for activities at *welding* and *hemming* stations, where operators complain of pain in body parts, namely the back, waist, and hips.
2. The company needs to make improvements, such as repairing the workstation, adding tools, improving posture, and increasing knowledge about work. With these improvements, the REBA value will decrease from high to medium, reducing the disturbances caused by MSDs.

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