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# Analysis Posture Work for Reduce Risk of *Musculoskeletal Disorders* (MSDs) with REBA Method in Wooden Ship Manufacturing Industry

Septa Prastiya Abidin[1], Lukman Handoko[2*], Indri Santiasih[1]
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***Abstract*—** In today's industrial era, work intensity increases along with consumer demand. Consequently, the workload experienced by workers must be considered, regardless of whether it is low, medium, or high. The focus of this study is the workload experienced by workers in the wooden shipbuilding industry. Lifting, cutting, and assembling are tasks frequently performed in the production area, requiring frequent repetition and long periods of time. Therefore, it can be concluded that these activities carry a very high risk and have a harmful impact on workers, causing muscle or bone injuries. The Nordic Body Map (NBM) questionnaire was used to conduct an initial assessment of the workload risk experienced by workers to determine workload risk. The results showed a high score for Musculoskeletal Disorder (MSD) complaints. Furthermore, further measurements of ergonomic risks were conducted using the Rapid Entire Body Assessment (REBA) method, so that design steps can be taken to improve work posture using the CATIA application to reduce the level of complaints that occur.

*Keywords*—*Nordic Body Map* (NBM), *Rapid Body Assessment* (REBA), *Musculoskeletal Disorders* (MSDs).

[*]*Corresponding Author: lukman.handoko@ppns.ac.id*

## I. INTRODUCTION

There is the current era of industrial modernization, namely the industrial revolution 4.0 [1] , also known as the fourth world industrial revolution, where information technology has become an important part of human life [2] . Due to the great advances in the internet and digital technology, which serves as the basis for movement [3] and connectivity between humans and machines, the use of unlimited computing power and data makes everything limitless [4] .

This has an impact on all aspects of industry in all countries in the world, including Indonesia where its geographical position is located on the ASIA continent, with the status of a developing country. [5] . Furthermore, in this case, based on several research references with several methods [6] , therefore, several research *gaps will be described* , between previous research and this research, which explains the description of the novelty of the research, including [7] , previous research was conducted in a different context in terms of industrial sector, location and population of objects [8] , *safety culture factors* that are different from previous research which are the basis for the novelty of this research [9] , adaptation of methods that are more relevant to the problems studied and taking a further approach to the research results that will be applied in work activities [10] .

Returning to this research which is located in a wood industry with MSDs complaint cases, so that it has a significant impact on the industry [11] , to the point of decreasing production performance, the following is a production performance curve that has experienced a decline and can be seen in the image below.

In this case, it is also strengthened by a diagram of measurement results using the *Nordic Body Map* (NBM) questionnaire [12] , data on the level of risk complaints based on the final scores taken from 25 wood industry workers, where 73% of workers experienced high complaints, 20% moderate and 7% low complaints.

We can observe above is a diagram of the measurement results using the *Nordic Body Map* (NBM) questionnaire, data on the level of risk complaints based on the final scores taken from 25 wood industry workers, how many as 73% of workers experienced high complaints, 20% moderate and 7% low complaints.

The REBA method was chosen because it has evenly distributed posture assessment items for the upper and lower body parts [6] . In accordance with worker complaint data obtained from the results of initial research using the NMB questionnaire , the final REBA score ( *grand score* ) [13] can then be used to analyze work stations that require immediate repair [14] .

Septa Prastiya Abidin, Master's Program in Safety and Risk Engineering, Shipbuilding Institute of Polytechnic Surabaya, Surabaya 60111, Indonesia. E-mail: septa.abidin@student.ppns.ac.id

Lukman Handoko, Occupational Health and Safety Department, Shipbuilding Institute of Polytechnic Surabaya, Surabaya 60111, Indonesia E-mail: lukman.handoko@ppns.ac.id

Indri Santiasih, Master's Program in Safety and Risk Engineering, Shipbuilding Institute of Polytechnic Surabaya, Surabaya 60111, Indonesia E-mail : indri.santiasih@ppns.ac.id

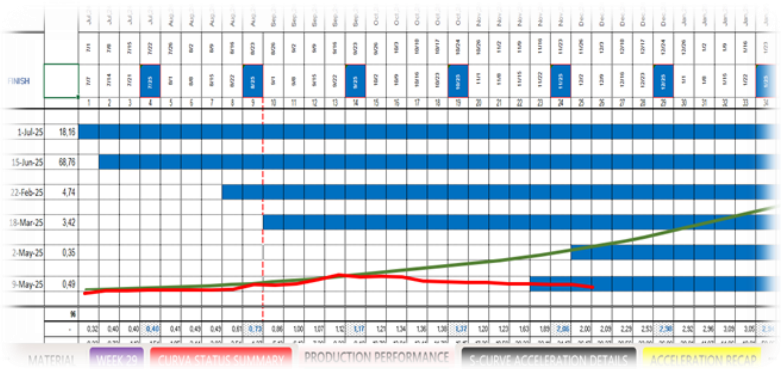

**Figure 1.** Production Performance Curve

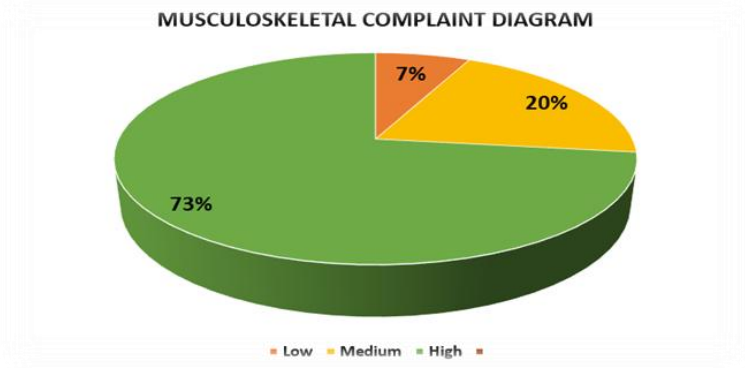


**Figure 2.** *Musculoskeletal* Complaints Diagram

**Figure 3.** Wood Cutting Process

## II. METHOD

A. This research is a type of analytical research with a case control design , namely research that concerns how risk factors are studied using an ergonomic approach [15] . In other words, the results of measuring the level of risk serve as a reference for the improvement process and implementation of existing improvement developments [16] .

B. Problem Identification Stages

The research conducted was to evaluate work stations based on the *Rapid Entire Body Assessment* (REBA) method [12] . Located in the wooden ship manufacturing industry which pays less attention to occupational health and safety aspects for these workers [5] . In general, each production division unit has limited work space and also these work activities are carried out for hours, causing fatigue in the workers' bodies [13] . Manual work activities that are carried out repeatedly and over a long period of time must receive great attention because they often cause the risk of injury and work accidents [1]

C. Work Posture Assessment Using the REBA Method

Work posture assessment was carried out on 1 worker in the wooden ship manufacturing industry using the REBA method [19] . The REBA *scoring calculation* for this activity begins by calculating the angle as shown in the image below [20] .

Next, *scoring is carried out* on the work posture during the wood cutting process activity in a standing and bending position, as follows:

1. Group A

a). *Scoring* on the body (*trunk)*It can be seen from Figure 4.1 that the body position is at a 47° angle, so the REBA score in this position is 3.

After obtaining the REBA score results in Table A in Table 4.2, the load score is added according to Table 1.1. In this wood cutting process, the load is less than 5 or force <5 kg. Therefore, the value is 0.

TABLE 1
REBA SCORES TABLE A

Table A

| Body | Neck | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | | | 2 | | | | 3 | | | |
| | Leg | | | | Leg | | | | Leg | | | |
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| 1 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 3 | 3 | 5 | 6 |
| 2 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 6 | 5 | 5 | 6 | 7 |
| 3 | 2 | 4 | 5 | 6 | 4 | 5 | 6 | 7 | 6 | 6 | 7 | 8 |
| 4 | 3 | 5 | 6 | 7 | 5 | 6 | 7 | 8 | 7 | 7 | 8 | 9 |
| 5 | 4 | 6 | 7 | 8 | 6 | 7 | 8 | 9 | 8 | 8 | 9 | 9 |

2) Group B

a) Scoring on the upper arm

The upper arm angle obtained from Figure 4.1 is 20°, including the flexed arm position > 20°, so the score is 1. The upper arm score must be added because the arm is lifted away from the body, so it is added + 1, so the total upper arm score is 2.

TABLE 2
REBA SCORES TABLE B

Table B

| Arm | Forearm | | | | | |
|---|---|---|---|---|---|---|
| | 1 | | | 2 | | |
| | Lower Wrist | | | Lower Wrist | | |
| | 1 | 2 | 3 | 1 | 2 | 3 |
| 1 | 1 | 2 | 2 | 1 | 2 | 3 |
| 2 | 1 | 2 | 3 | 2 | 3 | 4 |
| 3 | 3 | 4 | 5 | 4 | 5 | 5 |
| 4 | 4 | 5 | 5 | 5 | 6 | 7 |
| 5 | 6 | 7 | 7 | 7 | 8 | 8 |

b) Scoring on the forearm

The forearm angle obtained from Figure 4.1 is 89° including: in the forearm position of flexion > 60° so the score is 2.

c) Wrist scoring

The REBA score for the wrist in Figure 4.1 is 2 because the wrist position is flexed or extended > 15° and experiences torsion so it is increased by 1 to become 3.

Group B's score is determined using Table 4.2 in the REBA grand score calculation. Here's how to calculate the score:

Group B score is 4 plus the type of grip is a bad grip. In Table 2 the type of grip has a score of +3 then the score of group B becomes 7. Determining the total score for the work of the wood cutting process in a bent position by combining the scores of group A and group B using Table 2 by drawing a line down the 7 (score B) and horizontally the number 4 to the right will be known the value of the REBA Score table C, explained as follows:

TABLE 3
REBA SCORES TABLE C

| Score A | Table C: Score A | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | 1 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 7 | 7 |
| 2 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 |
| 3 | 2 | 3 | 3 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 8 | 8 |
| 4 | 3 | 4 | 4 | 4 | 5 | 6 | 7 | 8 | 8 | 9 | 9 | 9 |
| 5 | 4 | 4 | 4 | 5 | 6 | 7 | 8 | 8 | 9 | 9 | 9 | 9 |
| 6 | 6 | 6 | 6 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 10 |
| 7 | 7 | 7 | 7 | 8 | 9 | 9 | 9 | 10 | 10 | 11 | 11 | 11 |

The results of table C obtained will be added to the score for the type of muscle activity, so the score for table C is added + 1 because of the repetitive movements during the wood cutting process activity in a slightly bent standing position. Therefore, the REBA score for the wood cutting process in a bent position is 8. The following is a recapitulation of the calculated values for the wood cutting process activity in a bent position, which can be seen in Figure 5:

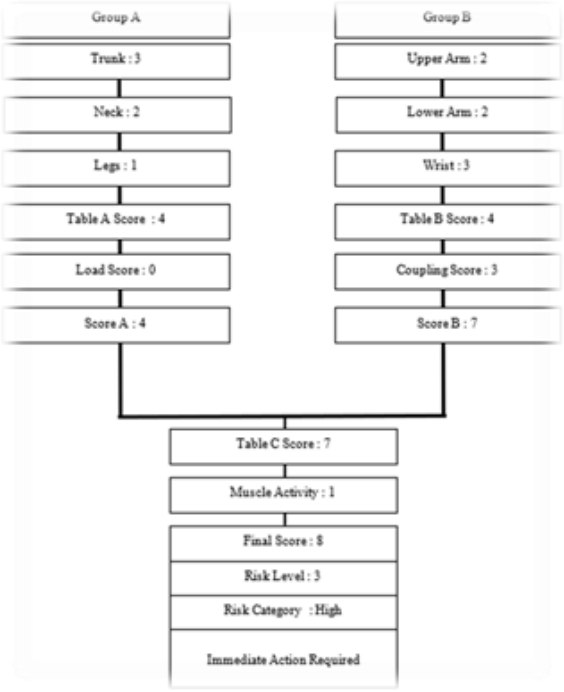


**Figure 5** Summary of Results of Calculation of Wood Cutting Process Activities

TABLE 4
ASSESSMENT SCORES

| REBA | | | | |
|---|---|---|---|---|
| **No** | **Type of Work Activity** | **REBA Score** | **Risk Level** | **Action** |
| 1 | Wood Cutting Process Activity | 8 | High | Immediate Action Required |

From the REBA score, the wood cutting activity in a bent position is known to have a final value of 8, where this risk category is included in the high category and immediate action is required.

D. Risk Level Results in Wood Cutting Process Activities

REBA score for wood cutting activities was obtained from the assessment . The job positions are shown in Table 4 below.

Table 4 shows that the scores obtained for the wood cutting process indicate a high risk level. Therefore, immediate improvements are needed by adding work facilities to reduce the risks.

## III. RESULT AND DISCUSSION

A. Engineering Control

After identifying the *ergonomic risk levels* in the woodcutting process, work facility improvements are

necessary as soon as possible. This is because the working posture of woodcutters poses a high risk of *musculoskeletal disorders* , necessitating improved posture. This improvement involves providing recommendations for work facility designs to lighten the workload and reduce the risk of postures that can lead to *musculoskeletal disorders* .

The improvements that will be made in this research are the addition of work chairs or the addition of tools to assist in the wood cutting process, this is because the wood cutting process activity in a bent position allows for improvements in work posture by adding work chairs.

The data and dimensions for the additional work facilities that will be designed using *anthropometric data* for Indonesian men (Nurmianto, 2004) at *the acerylene plant* are as follows:

**Figure 5.** Suggested Chair Designs

B. Additional Work Chair Facilities

a) Length of Chair Base

The size that will be used for the design of the chair base length is using *anthropometric data* with the dimension of the distance from the knees to the buttocks (D12) by taking the value of the 50% percentile for men, namely 40.5 cm. Use the 50% percentile because it is suitable for workers who have short knee folds but is still comfortable for workers who have long knee folds.

b) Chair Base Width

The dimensions used to design the seat base width are *anthropometric data* with the 95th percentile for men's hip width (D16) being 37.1 cm. The 95th percentile is used because it is suitable for workers with large hips and remains comfortable for workers with small hips. A 10 cm *allowance* is used for shifting when sitting, so the total seat base width is 47.1 cm.

c) Chair Height

The height of the chair to be used is adjusted to the lever height of 88 cm and the height of the chair back with the shoulder height dimension in the 50% percentile sitting position (D8), namely 57.2 cm. So the total chair height is 145.2 cm.

d) Seat Height to Footrest

The size that will be used for the height design to the footrest is using *anthropometry* with the knee fold height dimension (D14) 50% percentile is 40.3. The 50% *percentile* is used because the footrest height is not too high and short so it is suitable for workers who have long or short knee folds so that it is comfortable when working for a long time. A 4 cm *allowance* is used for the heel of the shoe so that the total height of the chair to the footrest is 44.3 cm.

The design of the work chair is designed using *the anthropometry* of Indonesian men to adjust the body posture and *ergonomics* when used, this work chair is an additional facility in the wood cutting process work carried out in a bent and squatting position, so that the worker's position when carrying out activities is replaced with a sitting position by adding this work chair which is expected to be able to reduce the level of *ergonomic risk.*

C. Assessment of Work Posture After Work Facility Improvements

Work Posture Assessment After Facility Improvements in wood cutting work , a work posture assessment was conducted again to determine the score for each work activity, after the work facility improvements were made. The design results were carried out using CATIA design.

D. Recapitulation of Assessment Results Before and After Work Facility Improvements

The following is a summary of the results of the work posture assessment before and after improvements to work facilities using the REBA method, with the output of the improvements being work chairs. This summary provides a clearer picture of the assessment results before and after the improvements.

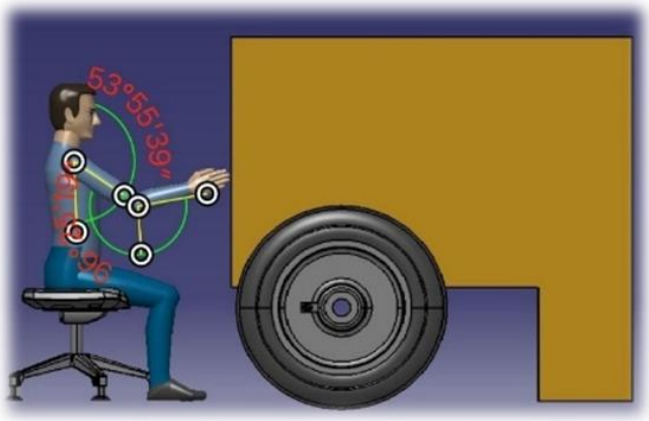


**Figure 6.** Wood Cutting Process Work Activities After Repair

TABLE 5
TABLE OF WORK ACTIVITIES FOR THE WOOD CUTTING PROCESS AFTER REPAIR

| Body Segment | score | *Grand Score* | Combined Score (Score C) | Table C | Final REBA Score | Risk Level | Risk Category | Action |
|---|---|---|---|---|---|---|---|---|
| **Group A** | | 1 | 1 + 0 = 1 | 1 | 1+1= 2 | 1 | Low | Action may not be required |
| Trunk | 1 | | | | | | | |
| Neck | 1 | | | | | | | |
| Legs | 1 | | | | | | | |
| **Group B** | | 1 | 1 + 0 = 1 | | | | | |
| Upper Arm | 2 | | | | | | | |
| Lower Arm | 1 | | | | | | | |
| Wrist | 1 | | | | | | | |

The results of the body posture assessment in Table 5 show that the addition of work facilities in the form of a work chair can reduce the final REBA score in the wood cutting process work activity . At the beginning of the assessment before the improvement had a score of 8, after the improvement had a score of 2 (low risk level). Therefore, it can be said that the addition of work facilities in the form of a work chair aid can reduce the level of risk in the wood cutting process work activity.

TABLE 6
SUMMARY RESULTS BEFORE AND AFTER IMPLEMENTATION OF WORK FACILITY IMPROVEMENTS

| No | Activity | Score Before Work Facility Improvement | Score After Work Facility Improvement |
|---|---|---|---|
| ***Wood Cutting Work*** | | | |
| 1 | Bending Posture | 8 (High) | 1 (Low) |

In Table 6, it can be seen that the score before the improvement of work facilities in the wood cutting process had a high risk level with a score of 8, which could cause a risk of muscle injury.

Then, after improvements were made to the work facilities, the score for each work activity decreased, with the score for the wood cutting process activity being 1. Thus, the risk of muscle injury and the potential for work-related illnesses in the wood cutting process can be reduced.

## V. CONCLUSION

Based on results study, observation And analysis data - data Which has carried out in the wooden ship manufacturing industry, it can be concluded that the wood cutting process carried out by these workers has not been carried out in accordance with the safe assessment score limits, which means that the wood cutting process has mark risk tall. Matter That due to existence mismatch posture body moment do activity the and the environment Work Which not enough *ergonomic.*

The wood cutting process workers in the wooden ship manufacturing industry have a high level of high risk, so there needs to be improvements fromin terms of body posture and facilities. By taking steps repairs and addition work facilities, the measurement value in the wood cutting process decreases significantly, so it can reduce level of risk of injury on worker.

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