# DESIGN MEASUREMENT FOR MANUFACTURING ERGONOMIC VALUE OF AN AUTOMOTIVE PART USING THE TOTAL ERGONOMIC APPROACH MODEL

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***ABSTRACT***

*This research designed the ergonomic value measurement using the Total Ergonomic Approach Model (TEAM) in an automotive parts and components manufacturer. The preliminary research by using Focused Group Discussion (FGD) showed that several variables obtained are: lack of nutrition, static working position, and non-ergonomic working position, manual material handling, above the limit noise level, manual production result note taking, non-computerized and duplicated process in the existing business process, delayed decision making by the Top Management, low workers' loyalty, low worker's welfare, and the non-existence of display application use. This paper describes the measurement was conducted only for four ergonomic aspects as follow the nutrition aspect using the Body Mass Index (BMI), work posture using the Rapid Upper Limb Assessment (RULA), muscle use aspect using the Recommended Weight Limit (RWL) and Lifting Index (LI) and working environment aspect using the OSHA 1910.953 method. Another aspects such as information and time, socio-cultural and human-machine interaction aspect are not included. Total Ergonomic Approach Model with Key Performance Indicators (KPI) shows that the company's performance for ergonomic value are good as well as satisfaction, neither their workers' performances.*

***Key words:*** *Total Ergonomic Approach Model (TEAM), Focused Group Discussion (FGD), Analytical Hierarchy Process (AHP), Key Performance Indicators (KPI).*

## 1. INTRODUCTION

The Total Ergonomic Approach by Manuaba (2004); Sutajaya (2005); Adiatmika (2010) in Adiatmika, 2011 stated that it was known that this method was able to correct various working conditions. However, the corrections were local and limited due to the limitation of the worker's knowledge and ability in conducting corrections, especially concerning knowledge in the Ergonomic field. This knowledge is considered important because these workers are the ones conducting the daily working activities, so that they are the ones who should've known which ones are Ergonomics and which ones are not. Another limitation is, the formal education in Ergonomics is somewhat limited and of course can't reach every worker available.

According to Adiatmika (2011) Total Ergonomic Approach Model (TEAM) is an implementation of the total ergonomic approach in the industrial environment. The concept adopted is trying to introduce the ergonomic concept simply to the workers or officers based on their working conditions. By understanding each working conditions, officers will know which working condition is ergonomic and which aren't. Therefore, the officers will realize and attracted to conduct simple corrections using resources available in their working environment. This can be done through seminars and classes to identify problems, determining priorities, and finding alternatives for further corrections. Corrections were done based on the Strength, Weakness, Opportunities, and Threats analysis as a basic in formulating the strategic and action plan.

This concept change from expert center to worker center according to Kogi (2006); Manuaba (2000); Sutajaya (2005), in Adiatmika (2011) said that this concept change will be able to conduct an ergonomic change through total ergonomic approach. In this matter, workers can be trained to improve their knowledge in

ergonomic through seminars, workshops, and classes so that they are aware of the ergonomic aspects of their work and working conditions and willing to correct them.

The total ergonomic approach [1], [2] was used as a form of ergonomic intervention that is willing to gain a more humane, competitive, and lasting method. This approach begins with problem identification consisted of 8 aspects: (a) nutrition, (b) work posture, (c) muscle use, (d) work environment, (e) time condition, (f) information condition, (g) socio-cultural condition, (h) human-machine interaction. The total ergonomic approach by Manuaba, (2004, 2005) in Adiatmika (2011) is a form of approach using the systemic, holistic, inter-discipline, and participative or known for short as SHIP. In choosing the working condition corrections, several aspects were taken into consideration. They are: technical, economic, ergonomic, socio-cultural, energy save, and environmental friendly (the proper use of technology). These two approaches altogether combined is known as the total approach.

## 2. BACKGROUND RESEARCH

This research was conducted in an automotive parts and components manufacturer that produces Clamp Clutch Cable & Clamp Pipe Brake, Clamp House and Bracket Bumper, Plug and Retainer, Dolly Chip Box, Dolly Delivery, Pallet Delivery, Table Roller Heavy Duty, Guntry Main Line Safety Fence. These products require good worker's stamina since the manufacturing processes involve heavy materials and repetitive works. Some other works also require good safety since they involve various hazardous materials. The finding from Focused Group Discussion (FGD) as follow:

*Firstly,* the worker appeared to lack of stamina in conducting his work, pale faced and spiritless as he isn't motivated in conducting his work, and often steal some time to rest in between activities.

*Secondly*, it is known that the worker's position is static and non-ergonomic. This posture is static, non-ergonomic, and repetitive for a long time period. The posture that involves stiff neck and bent forward body, hand posture that is stiff and bent appeared to be unnatural. Moreover, the leg position appeared imbalanced in supporting the body.

*Thirdly*, it is known that materials handling between workstations are conducted manually. Lifting is not supported by proper devices. Workers need to lift materials weighted 3 to 50 kg regularly, causing more burden to their muscle. This condition is prone to cause muscle aches in the long run.

*Fourthly*, there are large noises coming from the production floor. Further investigation shown that those noises come from the steel plate cutting process conducted in the floor. From the secondary data analysis, the noise level in the production floor can be analyzed as follow (Table 1):

Table 1. Noise Level Measurement

| No. | Location | NAB(Db) | Results | Note |
|---|---|---|---|---|
| 1 | Gate Area | 85 | 64.5 | ≤NAB |
| 2 | M. Cutting Plat | 85 | 92.5 | ≥NAB |
| 3 | Cutting | 85 | 104.5 | ≥NAB |
| 4 | Lathe Area | 85 | 888.3 | ≥NAB |
| 5 | Drill Area | 85 | 77.2 | ≤NAB |
| 6 | Welding Area | 85 | 72.1 | ≤NAB |
| 7 | Stamping Area | 85 | 73.5 | ≤NAB |
| 8 | Cutting Stamping Area | 85 | 82.4 | ≤NAB |
| 9 | Stamping II Area | 85 | 74.6 | ≤NAB |
| 10 | Bending Area | 85 | 72.9 | ≤NAB |
| 11 | Assembly Area | 85 | 87.8 | ≤NAB |
| 12 | Raw material Area | 85 | 65.7 | ≤NAB |
| 13 | Finished Good Area | 85 | 78.2 | ≤NAB |
| 14 | Office Area | 85 | 63.8 | ≤NAB |

Based on Table 1 above, there are 4 (four) areas in the company that has a high noise level (above the level suggested by the government regulation: Keputusan Menteri KEP. 51/MEN/1999 with maximum noise level of 85 decibel A (dBA). The four areas are the Plate Cutting Machine Area (92.5

dB), Cutting area (104.5 dB), Milling area (88.3 dB), and Assembling area (87.8 dB). Workers in those areas do not wear any protection against the noise like ear plug. In the long run, this condition can cause fatal damage of hearing loss.

*Fifthly* and *sixthly*, the production result report and workers' attendances reports are still taken manually. The company doesn't have any database as a storage media to store the information. This can cause a delay in delivering the information to the top management.

*Seventhly*, almost every month, a number of workers resign from the company and the company must conduct recruitment process to find new workers. Based on the absence and turn over counts during January-July, 2011, the average absence percentage is 1.04% per month and the average turn over percentage is 7.83% per month. That result is of course below the company's expectation, even below the World Class Operator (WCO) standard i.e. the WCO-007 on absence (<1%) and the WCO-006 on turn over standard (<7%) as cited from http://www.oocities.org/ wall street /floor/ 9096/ indikator.html /31/01/2012. It is also found that the worker's welfare is not in the company's top priority. Almost 90% of the salary/month (see Appendix B) lays under the Banten province's minimum salary standard of Rp. 1.379.000/month (Surat Keputusan Gubernur No. 561/Kep.886-Huk/2011 dated 21 Nov 2011 as cited from http://id.shvoong.com/ business-management/human-resources/2233887-umk-propinsi-banten-dan-dki/10/01/2012).

*Eighthly,* based on direct observation, it is found that in company does not apply any use of display in its area.

The problem appears as there is no ergonomic measurement standard in the company while there is need to apply ergonomic principle to solve above issues. This research analyze and design ergonomic working condition measurement using Total Ergonomic Approach Model (TEAM) method.

## 3. RESEARCH METHODOLOGY

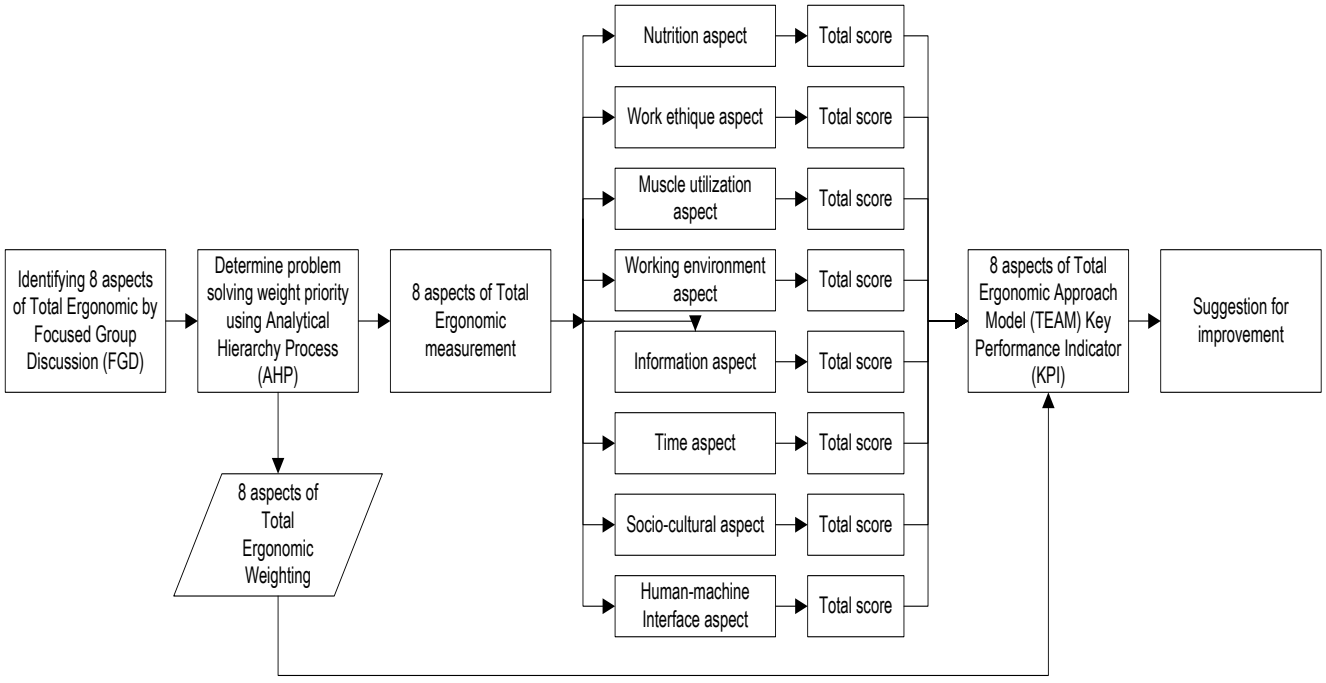


Figure 1. Research Methodology

### 3.1. Nutrition Status Measurement

The nutrition status measurement for adult is conducted using the Body Mass Index method (BMI) which is based on the body height (m) and body weight (kg) of the company's workers. An example of the calculation is as followed while the complete calculation result can be seen in Appendix B. The formula used to calculate the BMI is:

$$IMT = \frac{BB(kg)}{TB^2(m)}$$

Where :
BB : Weight (Kg)
TB : Height (m)

### 3.2. Muscle Use Aspect

Muscle use aspect is a problem identification aspect based on the operator's activities in the production floor. Material handling from one work station to another is still conducted manually

**a. Muscle Use Aspect Data Collection**

**1)** Questionnaire Result Recapitulation Data

***Nordic Body Map***

Based on the workers' working posture, it is found that the postures are static and repetitive. In the long run, this will cause aches and complaints due to those poor postures. In this research, a Nordic Body Map questionnaire is given to 12 random workers based on the sampling method.

**b. Muscle Use Aspect Data Processing**

1) Calculation of Recommended Weight Limit (RWL) and Lifting Index (LI)

**Recommended Weight Limit (RWL) RWL = LC X HM X VM X DM X AM X FM X CM**

Table 2. Recommended Weight Limit (RWL) (Source: Waters et al, 1994)

| | | *METRIC* | *US CUSTOMARY* |
|---|---|---|---|
| *Load Constant* | LC | 23 kg | 51 LB |
| *Horizontal Multiplier* | HM | (25/H) | (10/H) |
| *Vertical Multiplier* | VM | 1-(.003 [V-75]) | 1-(.0075 [V-30]) |
| *Distance Multiplier* | DM | .82 + (4.5/D) | .82 + (1.8/D) |
| *Asymmetric Multiplier* | AM | 1-(.0032A) | 1-(.0032A) |
| *Frequency Multiplier* | FM | *From Table 5* | *From Table 5* |
| *Coupling Multiplier* | CM | *From Table 7* | *From Table 7* |

b) Lifting Index (LI)

### 3.3. Work Posture Measurement

The Work Posture aspect research data was based on the worker's working position during their work activities. Eight workers are chosen to be the research subjects based on their postures while conducting the plating process, rolling I process, assembling process, finishing I process, finishing II process, blanking process, welding process, and rolling II process.

**a. Work Posture Aspect Data Processing**

The method used in conducting this aspect measurement is the Rapid Upper Limb Assessment Method (RULA). This method is used to identify works that may cause damage to the back bone. Some body parts used as measuring points include the upper arm, lower arm, wrist, wrist twist, neck, trunk, and legs.

## 4. RESULT AND DISCUSSION

### 4.1. Nutrition Status Measurement

The measurement conducted for nutrition status is restricted to measurement using Body Mass Index (BMI). Anthropometry Data used are body height and weight. Calculation result is as follows (Table 3)

Table 3. The company's Nutrition Status Measurement Recapitulation Data

| No | Name | Department | Weight (Kg) | Height (cm) | Height (M) | BMI | Nutrition Status | Score |
|---|---|---|---|---|---|---|---|---|
| 1 | Atik | HRD | 55 | 162 | 1.62 | 20.96 | Very Good | 5 |
| 2 | Giyarto | QC Manager | 66 | 172 | 1.72 | 22.31 | Very Good | 5 |
| 3 | Anjar | PPIC Manager | 62 | 163 | 1.63 | 23.34 | Very Good | 5 |
| 4 | Asmuni | Production | 62 | 173 | 1.73 | 20.72 | Very Good | 5 |

Table 3. The company's Nutrition Status Measurement Recapitulation Data (cont.)

| No | Name | Department | Weight (Kg) | Height (cm) | Height (M) | BMI | Nutrition Status | Score |
|---|---|---|---|---|---|---|---|---|
| 5 | Mahfud | Production | 70 | 177 | 1.77 | 22.34 | Very Good | 5 |
| 6 | Nidin | Production | 51 | 165 | 1.65 | 18.73 | Good | 4 |
| 7 | Kodir | Molding | 50 | 169 | 1.69 | 17.51 | Bad | 2 |
| 8 | Purwoko | Welding | 55 | 171 | 1.71 | 18.81 | Good | 4 |
| 9 | Ansori | Driver | 58 | 164 | 1.64 | 21.56 | Very Good | 5 |
| 10 | Fajar | Milling | 62 | 172 | 1.72 | 20.96 | Very Good | 5 |
| 11 | Amin | Production | 55 | 160 | 1.6 | 21.48 | Very Good | 5 |
| 12 | Wahyu | Production | 59 | 174 | 1.74 | 19.49 | Very Good | 5 |
| 13 | Arif | Production | 66 | 171 | 1.71 | 22.57 | Very Good | 5 |
| 14 | Mardiani | Production | 46 | 169 | 1.69 | 16.11 | Very Bad | 1 |
| 15 | Mila | Production | 45 | 166 | 1.66 | 16.33 | Very Bad | 1 |
| 16 | Oni | Production | 47 | 168 | 1.68 | 16.65 | Very Bad | 1 |
| 17 | Habib | Welding | 67 | 174 | 1.74 | 22.13 | Very Good | 5 |
| 18 | Firmansyah | Welding | 61 | 170 | 1.7 | 21.11 | Very Good | 5 |
| 19 | Suryana | Welding | 66 | 172 | 1.72 | 22.31 | Very Good | 5 |
| 20 | Ruslan | Milling | 68 | 173 | 1.73 | 22.72 | Very Good | 5 |
| 21 | Rosidah | Production | 48 | 162 | 1.62 | 18.29 | Bad | 2 |
| 22 | Yunita | Production | 45 | 159 | 1.59 | 17.8 | Bad | 2 |
| 23 | Imam | Production | 69 | 174 | 1.74 | 22.79 | Very Good | 5 |
| 24 | Rully | Production | 65 | 174 | 1.74 | 21.47 | Very Good | 5 |
| 25 | Basri | Milling | 43 | 159 | 1.59 | 17.01 | Bad | 2 |
| 26 | Narul | Production | 56 | 168 | 1.68 | 19.84 | Very Good | 5 |
| 27 | Tri Febri | Production | 42 | 162 | 1.62 | 16 | Very Bad | 1 |
| 28 | Iwan | Production | 65 | 170 | 1.7 | 22.49 | Very Good | 5 |
| 29 | Nurjaya | Production | 53 | 167 | 1.67 | 19 | Very Good | 5 |
| 30 | Jamaludin | Production | 57 | 173 | 1.73 | 19.05 | Very Good | 5 |
| Jumlah skor (i) | | | | | | | | 120 |

Nutrision's Total Score (i) = $\Sigma i$
=(5+5+...+1+5+5+5) = 120

$$\text{Total score} = \frac{\sum(\text{BMI x i})}{\sum \text{i}} = 20.83$$

Table 4. Body Mass Index (BMI) Category

| Classification | Score | Category | BMI |
|---|---|---|---|
| Underweight | Score 1 | Very poor | <17.00 |
| | Score 2 | Poor | 17.00-18.40 |
| | Score 3 | Average | 18.40-18.49 |
| | Score 4 | Good | 18.50-19.00 |
| Normal | Score 5 | Very Good | 19.01-24.00 |
| Overweight | Score 4 | Good | 24.01-25.00 |
| | Score 3 | Average | 25.01-25.99 |
| | Score 2 | Poor | 26.00-27.00 |
| | Score 1 | Very Poor | >27.00 |

Calculation result using Body Mass Index in Table 5 shows very good result (scored 5) for average BMI of 20.83. The nutrition status calculation result using the BMI method can be seen in Table 3 and the total score obtained is 20.83 or very good with a score of 5 based on Table 4.

### 4.2. Work Posture Aspect

Below are worker pictures example in various work postures in Production and Assembly department that will be analyzed using *Rapid Upper Limb Assessment* (RULA) method.

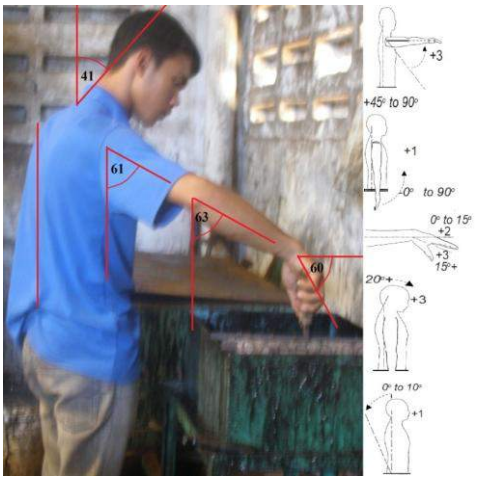


Figure 1. Work Posture in conducting the Plating process

Figure 2. Work Posture in conducting the Rolling I process

Figure 3. Work Posture in conducting the Assembling process

### a. Work Posture Aspect Data Processing

The method used in conducting this aspect measurement is the Rapid Upper Limb Assessment Method (RULA). This method is used to identify works that may cause damage to the back bone. Some body parts used as measuring points include the upper arm, lower arm, wrist, wrist twist, neck, trunk, and legs. In the calculation, those body parts are divided into two score groups i.e. Table A and Table B. Table A consists of scoring of upper arm, lower arm, wrist, wrist twist with muscle use and additional burden as the items that will add the score. Table B consists of scoring of the neck, trunk, and legs with muscle use and additional burden as the items that will add the score. The score in Table A then added to the score in Table B to obtain the final score that will be used as the basic score of the work posture aspect. An example of calculation using RULA method on blanking process is as follow (see Figure ):

Figure 4. Work Posture in conducting the Finishing I process

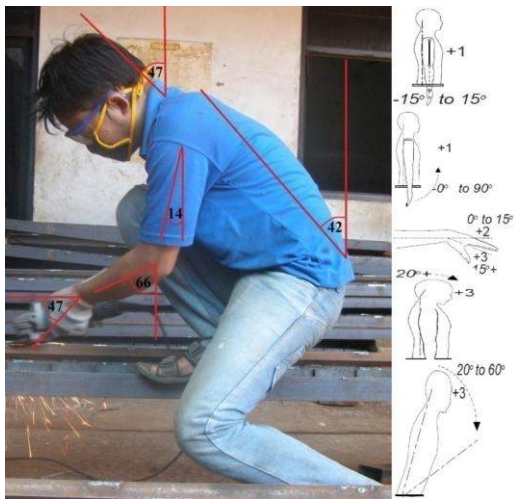

Figure 5. Work Posture in conducting the Finishing II process

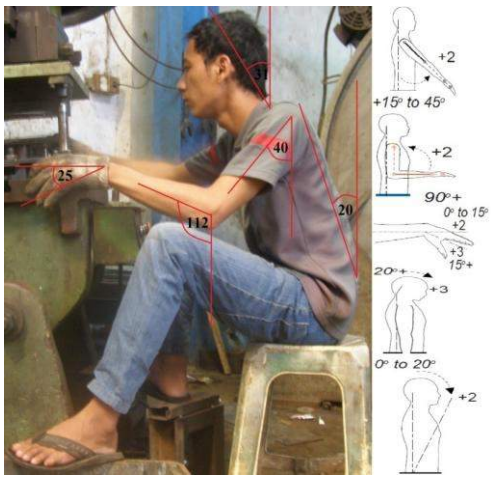

Figure 6. Work Posture in conducting the Blanking process

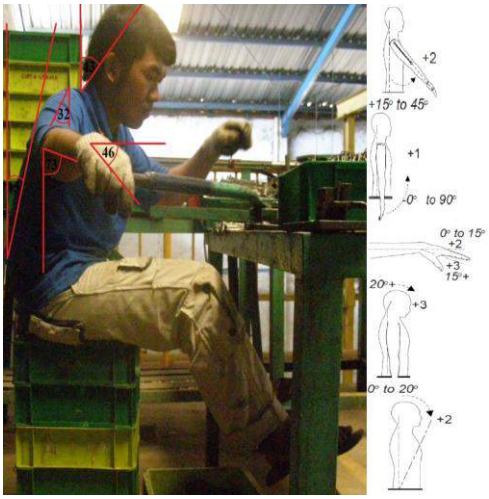


Figure 7. Work Posture in conducting the Rolling II process

In the calculation, those body parts are divided into two score groups i.e. Table A and Table B. Table A consists of scoring of upper arm, lower arm, wrist, wrist twist with muscle use and additional burden as the items that will add the score. Table B consists of scoring of the neck, trunk, and legs with muscle use and additional burden as the items that will add the score. The score in Table A then added to the score in Table B to obtain the final score that will be used as the basic score of the work posture aspect. An example of calculation using RULA method on blanking process is as follow :

Table 7. Work Posture Aspect Scoring Result

| Subject | Dept | Table A | | | | Score Table A | Add Muscle Use Score | Add Force/Load Score | Score Table C |
|---|---|---|---|---|---|---|---|---|---|
| | | Upper Arm | Lower Arm | Wrist | Wrist Twist | | | | |
| Plating Worker | Manufg | 4 | 2 | 4 | 1 | 5 | 1 | 0 | 6 |
| Rolling Worker | Manufg | 2 | 2 | 3 | 1 | 3 | 1 | 0 | 4 |
| Assembling Worker | Manufg | 2 | 2 | 4 | 1 | 4 | 1 | 0 | 5 |
| Finishing I Worker | Manufg | 1 | 1 | 3 | 1 | 2 | 1 | 0 | 3 |
| Finishing II Worker | Manufg | 1 | 1 | 4 | 1 | 3 | 1 | 3 | 7 |
| Blanking Worker | Manufg | 2 | 2 | 4 | 1 | 4 | 1 | 0 | 5 |
| Welding Worker | Manufg | 1 | 1 | 4 | 1 | 3 | 1 | 1 | 5 |
| Bending Worker | Manufg | 3 | 2 | 3 | 1 | 4 | 1 | 0 | 5 |

Table 8 Work Posture Aspect Scoring Result (Continued)

| Subject | Table B | | | Score Table B | Add Muscle Use | Add Force /Load Score | Score Table C | Final Score | Risk Level | Score (i) | Action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Neck | Trunk | Legs | | | | | | | | |
| Plating Worker | 3 | 1 | 1 | 3 | 1 | 0 | 4 | 6 | Poor | 2 | Need immediate attention |
| Rolling Worker | 3 | 3 | 1 | 4 | 1 | 0 | 5 | 5 | Poor | 2 | Need immediate attention |
| Assembling Worker | 3 | 2 | 1 | 3 | 1 | 0 | 4 | 5 | Poor | 2 | Need immediate attention |
| Finishing I Worker | 3 | 3 | 2 | 5 | 1 | 0 | 6 | 5 | Poor | 2 | Need immediate attention |
| Finishing II Worker | 3 | 3 | 2 | 5 | 1 | 3 | 9 | 7 | Very poor | 1 | Need corrective action now |
| Blanking Worker | 3 | 2 | 1 | 3 | 1 | 0 | 4 | 5 | Poor | 2 | Need immediate attention |
| Welding Worker | 3 | 3 | 2 | 5 | 1 | 1 | 7 | 7 | Very poor | 1 | Need corrective action now |
| Bending Worker | 3 | 2 | 1 | 3 | 1 | 0 | 4 | 5 | Poor | 2 | Need immediate attention |
| | | | | | | | | Total | 5 | 14 | Need immediate attention |

Table 9. Work Posture Aspect Scoring

| Scoring Classification | | | |
|---|---|---|---|
| Score | Final Score | Category | Remark |
| 5 | 0 | Very good | No action needed (None Necessary) |
| 4 | 1 or 2 | Good | Improvement might be taken (Maybe Necessary) |
| 3 | 3 or 4 | Average | Need improvement (Necessary) |
| 2 | 5 or 6 | Poor | Need immediate attention (Necessary Soon) |
| 1 | 7 | Very poor | Need corrective action now (Necessary Now) |

Table 10. *Lifting Index* (LI) Origin

| LC | HM | VM | DM | AM | FM | CM | RWL | LI | Remark | Score (i) | Job Title |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 0.56 | 0.96 | 0.92 | 1 | 1 | 1 | 11.38 | 2.2 | Very poor | 1 | Distribution |
| 23 | 0.56 | 0.82 | 0.87 | 1 | 1 | 1 | 9.19 | 2.72 | Very poor | 1 | |
| 23 | 0.56 | 0.69 | 0.85 | 1 | 1 | 1 | 7.55 | 3.31 | Very poor | 1 | |
| 23 | 0.53 | 0.96 | 0.89 | 0.86 | 0.97 | 1 | 8.69 | 3.45 | Very poor | 1 | Warehousing |
| 23 | 0.53 | 0.96 | 1.05 | 0.86 | 0.97 | 1 | 10.25 | 2.93 | Very poor | 1 | |
| 23 | 0.53 | 0.96 | 0.91 | 0.86 | 0.97 | 1 | 8.88 | 3.38 | Very poor | 1 | |
| 23 | 1.25 | 0.93 | 1.27 | 0.9 | 1 | 1 | 30.56 | 1.47 | Poor | 2 | Raw material unloading |
| 23 | 0.83 | 0.96 | 0.95 | 0.86 | 0.91 | 0.95 | 12.94 | 0.23 | Very good | 5 | Plat loading to Shearing Machine |
| 23 | 1 | 0.96 | 0.95 | 0.9 | 0.91 | 1 | 17.18 | 0.17 | Very good | 5 | Plat transporting to blank machine |
| 23 | 1.25 | 0.93 | 1.05 | 0.86 | 1 | 1 | 24.14 | 2.07 | Very poor | 1 | Shipping |
| | | | | | | | | | Total score (i) | 19 | |

Table 11. Lifting Index (LI) Destination

| LC | HM | VM | DM | AM | FM | CM | RWL | LI | Remark | Score (i) | Job Title |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 0.31 | 0.91 | 0.92 | 0.86 | 1 | 1 | 5.13 | 4.87 | Very poor | 1 | Distribution |
| 23 | 0.31 | 0.91 | 0.87 | 0.86 | 1 | 1 | 4.85 | 5.15 | Very poor | 1 | |
| 23 | 0.31 | 0.91 | 0.85 | 0.86 | 1 | 1 | 4.74 | 5.27 | Very poor | 1 | |
| 23 | 0.4 | 0.85 | 0.89 | 0.86 | 0.97 | 1 | 5.81 | 5.16 | Very poor | 1 | Warehousing |
| 23 | 0.4 | 0.99 | 1.05 | 0.86 | 0.97 | 1 | 7.98 | 3.76 | Very poor | 1 | |
| 23 | 0.4 | 0.81 | 0.91 | 0.86 | 0.97 | 0.95 | 5.37 | 5.59 | Very poor | 1 | |
| 23 | 0.25 | 0.9 | 1.27 | 0.9 | 1 | 1 | 5.92 | 7.6 | Very poor | 1 | Raw material unloading |
| 23 | 0.16 | 0.94 | 0.95 | 0.86 | 0.91 | 1 | 2.57 | 1.17 | Poor | 2 | Plat loading to Shearing Machine |
| 23 | 0.06 | 0.94 | 0.95 | 0.9 | 0.91 | 0.95 | 0.96 | 3.13 | Very poor | 1 | Plat transporting to blank machine |
| 23 | 0.42 | 0.87 | 1.05 | 0.86 | 1 | 1 | 7.59 | 6.59 | Very poor | 1 | Shipping |
| | | | | | | | | Total score (a) | 2.48 | 11 | |

From Table 7 and 8, the final score for Work Posture Aspect is 5. Table 9 shows that the result is 'Poor' and need immediate action for improvement.

### 4.3. Muscle Utilization Aspect

*Recommended Weight Limit* (RWL) method is applied to six samples of manual handling activities, the result is as in Table 10 and 11 below.

### 4.4. Work Environment Aspect

The work environment aspect that being observed is noise level based on the serult of Focused Group Discussion (FGD). Measurement is using OSHA 1910.95 method and the result is as follow

Table 12 Muscle Utilization Aspect Scoring

| Scoring | | |
|---|---|---|
| Score 5 | Very good | LI $\leq$ 0.25 |
| Score 4 | Good | 0.26 < LI $\leq$ 0.50 |
| Score 3 | Average | 0.50 < LI $\leq$ 1.00 |
| Score 2 | Poor | 1.01 < LI $\leq$ 1.99 |
| Score 1 | Very poor | LI $\geq$ 2.00 |

The overall Lifting Index (LI) based on calculation above is 2.48, which means the lifting condition in PT Cipta Utama Raya is very poor (scored 1).

Table 13. Work Environment Aspect Calculation

| No | Location of measurement | Upper Level Limit (dB) | Conversion of Upper Level Limit (%) | Noise level (dB) | Permitted duration (hour) | Noise dosage - D (%) | Remark | |
|---|---|---|---|---|---|---|---|---|
| **1** | Gate | 85 | 50 | 63.5 | 315.17 | 2.3 | Very good | 5 |
| **2** | Plate Cutting Machine | 85 | 50 | 92.5 | 5.66 | 129 | Very poor | 1 |
| **3** | Cutting | 85 | 50 | 104.5 | 1.07 | 682.24 | Very poor | 1 |
| **4** | Lathe Area | 85 | 50 | 88.3 | 10.13 | 72.06 | Average | 3 |
| **5** | Drill Area | 85 | 50 | 77.2 | 47.18 | 16 | Good | 4 |
| **6** | Welding Area | 85 | 50 | 72.1 | 95.67 | 8 | Very good | 5 |
| **7** | Stamping I Area | 85 | 50 | 73.5 | 14.72 | 50 | Average | 3 |
| **8** | Sctamping Cutting Area | 85 | 50 | 82.4 | 10.85 | 67 | Average | 3 |
| **9** | Stamping II Area | 85 | 50 | 74.6 | 20.54 | 36 | Average | 3 |
| **10** | Blending Area | 85 | 50 | 72.9 | 85.63 | 9 | Very good | 5 |
| **11** | Assembling Area | 85 | 50 | 87.8 | 141.04 | 5 | Very good | 5 |
| **12** | Raw Material Area | 85 | 50 | 65.7 | 232.33 | 3 | Very good | 5 |
| **13** | Product Area | 85 | 50 | 78.2 | 108.38 | 7 | Very good | 5 |
| **14** | Office Area | 85 | 50 | 63.8 | 77.71 | 9 | Very good | 5 |
| | | | | | Total score | 33 | | 53 |

Table 14. Work Environment Aspect Scoring

| Scoring | | |
|---|---|---|
| Score 5 | **Very good** | **%D ≤ 10%** |
| Score 4 | **Good** | **10% < %D ≤ 28%** |
| Score 3 | **Average** | **29% < %D ≤ 82%** |
| Score 2 | **Poor** | **83% < %D ≤ 100%** |
| Score 1 | **Very poor** | **%D ≥ 100%** |

## 5. CONCLUSION

Based on the result it can be concluded that Focused Group Discussion (FGD) is the correct method to identify the ergonomic problem in the company. Weighting using the Analytical Hierarchy Process (AHP) using the FGD mechanism tends to be more qualitative because members of the discussion group discussed the importance level together so that an agreement on those subject are decided together. The Total Ergonomic Approach Model (TEAM) approach offers a complete ergonomic solution to the company's problem so that improvements and corrections can be done as integration and totally.

Scoring is conducted using the Likert 5 scale because this scaling offer a more complete and clear alternatives, not to mention more options to consider. From the calculation analysis it can be concluded that the nutrition aspect using the Body Mass Index (BMI) method has a total score of 20.83 and a score of 5, it means that the nutrition aspect is in a very good condition. The work posture aspect is analyzed using the Rapid Upper Limb Assessment (RULA) method, giving a total score of 5 or a 2 in the Likert

scale which means that it is bad so that an immediate correction is needed. The muscle use aspect using the Recommended Weight Limit (RWL) and Lifting Index (LI) has a total score of 2.48 or a 1 in the Likert score that means very bad so that a new lifting method is needed to be implemented immediately to avoid danger. The work environment aspect using the OSHA 1910.95 method has a total score of 33 or a 3 in the Likert scale, meaning that the noise level was mediocre and the company need to implement the use of ear plugs immediately. Key Performance Indicator (KPI) shows a result of 2.6637, it means that overall, the working condition in the company is bad and immediate improvements need to be conducted.

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