

LAMPIRAN 1

Data Kusiner *Nordic Body Map* (NBM)

- a. Data Kusiner *Nordic Body Map* Operator Mesin Double Sizer Pengangkatan Manual

No	Location	Level of Complaints			
		A	B	C	D
0	<i>Upper neck</i> /Atas leher	V			
1	<i>Lower neck</i> /Bawah leher	V			
2	<i>Left shoulder</i> /Kiri bahu		V		
3	<i>Right shoulder</i> /Kanan bahu		V		
4	<i>Left upper arm</i> /Kiri atas lengan		V		
5	<i>Back</i> /Punggung	V			
6	<i>Right upper arm</i> /Kanan atas lengan		V		
7	<i>Waist</i> /Pinggang			V	
8	<i>Buttock</i> /Pantat			V	
9	<i>Bottom</i> /Bagian bawah pantat				
10	<i>Left elbow</i> /Kiri siku	V			
11	<i>Right elbow</i> /Kanan siku	V			
12	<i>Left lower arm</i> /Kiri lengan bawah	V			
13	<i>Right lower arm</i> /Kanan lengan bawah	V			
14	<i>Left wrist</i> / Pergelangan tangan Kiri	V			
15	<i>Right wrist</i> / Pergelangan tangan Kanan	V			
16	<i>Left hand</i> / Tangan Kiri		V		
17	<i>Right hand</i> / Tangan Kanan		V		
18	<i>Left thigh</i> / Paha Kiri	V			
19	<i>Right thigh</i> / Paha Kanan	V			
20	<i>Left knee</i> / Lutut Kiri	V			
21	<i>Right knee</i> / Lutut Kanan	V			
22	<i>Left calf</i> / Betis Kiri		V		
23	<i>Right calf</i> / Betis Kanan		V		
24	<i>Left ankle</i> / Pergelangan kaki Kiri	V			
25	<i>Right ankle</i> / Pergelangan kaki Kanan	V			
26	<i>Left foot</i> /kaki kiri	V			
27	<i>Right foot</i> /kaki kanan	V			

- b. Data Kusioner *Nordic Body Map* Operator Mesin Double Sizer Pengangkatan Menggunakan *Automatic Handlift*

No	Location	Level of Complaints			
		A	B	C	D
0	<i>Upper neck</i> /Atas leher	V			
1	<i>Lower neck</i> /Bawah leher	V			
2	<i>Left shoulder</i> /Kiri bahu	V			
3	<i>Right shoulder</i> /Kanan bahu	V			
4	<i>Left upper arm</i> /Kiri atas lengan		V		
5	<i>Back</i> /Punggung	V			
6	<i>Right upper arm</i> /Kanan atas lengan		V		
7	<i>Waist</i> /Pinggang	V			
8	<i>Buttock</i> /Pantat	V			
9	<i>Bottom</i> /Bagian bawah pantat	V			
10	<i>Left elbow</i> /Kiri siku	V			
11	<i>Right elbow</i> /Kanan siku	V			
12	<i>Left lower arm</i> /Kiri lengan bawah	V			
13	<i>Right lower arm</i> /Kanan lengan bawah	V			
14	<i>Left wrist</i> / Pergelangan tangan Kiri	V			
15	<i>Right wrist</i> / Pergelangan tangan Kanan	V			
16	<i>Left hand</i> / Tangan Kiri		V		
17	<i>Right hand</i> / Tangan Kanan		V		
18	<i>Left thigh</i> / Paha Kiri	V			
19	<i>Right thigh</i> / Paha Kanan	V			
20	<i>Left knee</i> / Lutut Kiri	V			
21	<i>Right knee</i> / Lutut Kanan	V			
22	<i>Left calf</i> / Betis Kiri		V		
23	<i>Right calf</i> / Betis Kanan		V		
24	<i>Left ankle</i> / Pergelangan kaki Kiri	V			
25	<i>Right ankle</i> / Pergelangan kaki Kanan	V			
26	<i>Left foot</i> /kaki kiri	V			
27	<i>Right foot</i> /kaki kanan	V			

c. Data Kusioner *Nordic Body Map* Operator Mesin Ban Saw Pengangkatan Manual

No	Location	Level of Complaints			
		A	B	C	D
0	<i>Upper neck</i> /Atas leher			V	
1	<i>Lower neck</i> /Bawah leher			V	
2	<i>Left shoulder</i> /Kiri bahu				V
3	<i>Right shoulder</i> /Kanan bahu				V
4	<i>Left upper arm</i> /Kiri atas lengan			V	
5	<i>Back</i> /Punggung			V	
6	<i>Right upper arm</i> /Kanan atas lengan			V	
7	<i>Waist</i> /Pinggang				V
8	<i>Buttock</i> /Pantat				V
9	<i>Bottom</i> /Bagian bawah pantat				V
10	<i>Left elbow</i> /Kiri siku			V	
11	<i>Right elbow</i> /Kanan siku			V	
12	<i>Left lower arm</i> /Kiri lengan bawah				V
13	<i>Right lower arm</i> /Kanan lengan bawah				V
14	<i>Left wrist</i> / Pergelangan tangan Kiri				V
15	<i>Right wrist</i> / Pergelangan tangan Kanan				V
16	<i>Left hand</i> / Tangan Kiri				V
17	<i>Right hand</i> / Tangan Kanan				V
18	<i>Left thigh</i> / Paha Kiri			V	
19	<i>Right thigh</i> / Paha Kanan			V	
20	<i>Left knee</i> / Lutut Kiri		V		
21	<i>Right knee</i> / Lutut Kanan		V		
22	<i>Left calf</i> / Betis Kiri		V		
23	<i>Right calf</i> / Betis Kanan		V		
24	<i>Left ankle</i> / Pergelangan kaki Kiri			V	
25	<i>Right ankle</i> / Pergelangan kaki Kanan			V	
26	<i>Left foot</i> /kaki kiri				V
27	<i>Right foot</i> /kaki kanan				V

- d. Data Kusioner *Nordic Body Map* Operator Mesin Ban Saw Pengangkatan Menggunakan *Manual Handlift*

No	Location	Level of Complaints			
		A	B	C	D
0	<i>Upper neck</i> /Atas leher	V			
1	<i>Lower neck</i> /Bawah leher	V			
2	<i>Left shoulder</i> /Kiri bahu		V		
3	<i>Right shoulder</i> /Kanan bahu		V		
4	<i>Left upper arm</i> /Kiri atas lengan			V	
5	<i>Back</i> /Punggung	V			
6	<i>Right upper arm</i> /Kanan atas lengan			V	
7	<i>Waist</i> /Pinggang	V			
8	<i>Buttock</i> /Pantat	V			
9	<i>Bottom</i> /Bagian bawah pantat	V			
10	<i>Left elbow</i> /Kiri siku		V		
11	<i>Right elbow</i> /Kanan siku		V		
12	<i>Left lower arm</i> /Kiri lengan bawah		V		
13	<i>Right lower arm</i> /Kanan lengan bawah		V		
14	<i>Left wrist</i> / Pergelangan tangan Kiri			V	
15	<i>Right wrist</i> / Pergelangan tangan Kanan			V	
16	<i>Left hand</i> / Tangan Kiri			V	
17	<i>Right hand</i> / Tangan Kanan			V	
18	<i>Left thigh</i> / Paha Kiri	V			
19	<i>Right thigh</i> / Paha Kanan	V			
20	<i>Left knee</i> / Lutut Kiri	V			
21	<i>Right knee</i> / Lutut Kanan	V			
22	<i>Left calf</i> / Betis Kiri	V			
23	<i>Right calf</i> / Betis Kanan	V			
24	<i>Left ankle</i> / Pergelangan kaki Kiri	V			
25	<i>Right ankle</i> / Pergelangan kaki Kanan	V			
26	<i>Left foot</i> /kaki kiri	V			
27	<i>Right foot</i> /kaki kanan	V			

LAMPIRAN 2

Langkah Pengolahan Data Metode REBA Menggunakan *Software Ergofellow*

- a. Operator Mesin Double Sizer Pengangkatan Menggunakan *Automatic Handlift*
Berikut ini merupakan tahapan pengolahan data menggunakan *software Ergofellow*.

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs Load Upper arm, lower arm and wrist Coupling Activity

Neck, trunk and legs

Neck

In extension 0 to 20 degrees More than 20 degrees

Additional

Neck is twisted or side bending

Trunk

In extension Straight 0 to 20 degrees 20 to 60 degrees More than 60 degrees

Additional

Trunk is twisted or side bending

Legs

Support in the two legs, walking or seated Support in one leg 30 to 60 degrees More than 60 degrees

Gambar.1 Identifikasi Postur Grup A

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs Load Upper arm, lower arm and wrist Coupling Activity

Load

Load < 5 kg
Load < 11 lb Load 5 to 10 kg
Load 11 to 22 lb Load > 10 kg
Load > 22 lb

Additional

Shock or rapid build up of force

Gambar.2 Identifikasi Beban Operator

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Upper arm, lower arm and wrist

Upper arm

In extension more than 20 degrees
 - 20 to 20 degrees
 20 to 45 degrees
 45 to 90 degrees
 More than 90 degrees

Additional

Upper arm is abducted
 Shoulder is raised
 Arm is supported or person is leaning

Lower arm

60 to 100 degrees
 0 to 60 degrees or more than 100 degrees

Wrist

Between 15 degrees up and 15 degrees down
 More than 15 degrees up or more than 15 degrees down

Additional

Wrist is bent from midline or twisted

Gambar.3 Identifikasi Postur Grup B

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Coupling

Good
 Fair
 Poor
 Unacceptable

Gambar.4 Identifikasi *Coupling* (Genggaman)

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Activity

One or more body parts are held for longer than 1 minute (static)

Repeated small range actions (more than 4x per minute)

Action causes rapid large range changes in postures or unstable base

Gambar.5 Identifikasi *Activity Score*

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

RESULT

SCORE: **4**

SCORE	RISK
1	Negligible risk
2 or 3	Low risk, change may be needed
4 to 7	Medium risk, further investigation, change soon
8 to 10	High risk, investigate and implement change
11 or more	Very high risk, implement change

RESULT
 SAVE
 DATABASE
 CONTROL
 INFORMATION

Gambar.6 Skor Akhir REBA

b. Operator Mesin Ban Saw Pengangkatan Manual

Berikut ini merupakan tahapan pengolahan data menggunakan *software* Ergofellow.

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs Load Upper arm, lower arm and wrist Coupling Activity

Neck, trunk and legs

Neck

In extension 0 to 20 degrees More than 20 degrees

Additional

Neck is twisted or side bending

Trunk

In extension Straight 0 to 20 degrees 20 to 60 degrees More than 60 degrees

Additional

Trunk is twisted or side bending

Legs

Support in the two legs, walking or seated Support in one leg

Additional

30 to 60 degrees More than 60 degrees

Gambar.7 Identifikasi Postur Grup A

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs Load Upper arm, lower arm and wrist Coupling Activity

Load

Load < 5 kg
Load < 11 lb Load 5 to 10 kg
Load 11 to 22 lb Load > 10 kg
Load > 22 lb

Additional

Shock or rapid build up of force

Gambar.8 Identifikasi Beban Operator

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Upper arm, lower arm and wrist

Upper arm

In extension more than 20 degrees
 - 20 to 20 degrees
 20 to 45 degrees
 45 to 90 degrees
 More than 90 degrees

Additional

Upper arm is abducted
 Shoulder is raised
 Arm is supported or person is leaning

Lower arm

60 to 100 degrees
 0 to 60 degrees or more than 100 degrees

Wrist

Between 15 degrees up and 15 degrees down
 More than 15 degrees up or more than 15 degrees down

Additional

Wrist is bent from midline or twisted

Gambar.9 Identifikasi Postur Grup B

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Coupling

Good
 Fair
 Poor
 Unacceptable

Gambar.10 Identifikasi *Coupling* (Genggaman)

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Activity

One or more body parts are held for longer than 1 minute (static)

Repeated small range actions (more than 4x per minute)

Action causes rapid large range changes in postures or unstable base

Gambar.11 Identifikasi Activity Score

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

RESULT

SCORE: **8**

SCORE	RISK
1	Negligible risk
2 or 3	Low risk, change may be needed
4 to 7	Medium risk, further investigation, change soon
8 to 10	High risk, investigate and implement change
11 or more	Very high risk, implement change

RESULT

SAVE

DATABASE

CONTROL

INFORMATION

Gambar.12 Skor Akhir REBA

c. Operator Mesin Double Sizer Pengangkatan Menggunakan *Manual Handlift*
Berikut ini merupakan tahapan pengolahan data menggunakan *software* Ergofellow.

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs Load Upper arm, lower arm and wrist Coupling Activity

Neck, trunk and legs

Neck

In extension 0 to 20 degrees More than 20 degrees

Additional

Neck is twisted or side bending

Trunk

In extension Straight 0 to 20 degrees 20 to 60 degrees More than 60 degrees

Additional

Trunk is twisted or side bending

Legs

Support in the two legs, walking or seated Support in one leg 30 to 60 degrees More than 60 degrees

Gambar.13 Identifikasi Postur Grup A

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs Load Upper arm, lower arm and wrist Coupling Activity

Load

Load < 5 kg
Load < 11 lb Load 5 to 10 kg
Load 11 to 22 lb Load > 10 kg
Load > 22 lb

Additional

Shock or rapid build up of force

Gambar.14 Identifikasi Beban Operator

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Upper arm, lower arm and wrist

Upper arm

In extension more than 20 degrees
 -20 to 20 degrees
 20 to 45 degrees
 45 to 90 degrees
 More than 90 degrees

Additional

Upper arm is abducted
 Shoulder is raised
 Arm is supported or person is leaning

Lower arm

60 to 100 degrees
 0 to 60 degrees or more than 100 degrees

Wrist

Between 15 degrees up and 15 degrees down
 More than 15 degrees up or more than 15 degrees down

Additional

Wrist is bent from midline or twisted

Gambar.15 Identifikasi Postur Grup B

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Coupling

Good
 Fair
 Poor
 Unacceptable

Gambar.16 Identifikasi *Coupling* (Genggaman)

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs
 Load
 Upper arm, lower arm and wrist
 Coupling
 Activity

Activity

One or more body parts are held for longer than 1 minute (static)

Repeated small range actions (more than 4x per minute)

Action causes rapid large range changes in postures or unstable base

Gambar.17 Identifikasi *Activity Score*

REBA

CHOOSE AN OPTION BELOW

Neck, trunk and legs Load Upper arm, lower arm and wrist Coupling Activity

RESULT

SCORE: **5**

SCORE	RISK
1	Negligible risk
2 or 3	Low risk, change may be needed
4 to 7	Medium risk, further investigation, change soon
8 to 10	High risk, investigate and implement change
11 or more	Very high risk, implement change

RESULT

SAVE

DATABASE

CONTROL

INFORMATION

Gambar.18 Skor Akhir REBA

LAMPIRAN 3

Langkah Perhitungan Metode MPL

- a. Perhitungan MPL Aktivitas Pengangkatan Menggunakan Alat *Automatic Handlift* Operator Mesin *Double Sizer*

Telapak Tangan

$$\begin{aligned}
 W_{\text{badan}} &= \text{massa badan} \times g & W_H &= 0,6\% \times W_{\text{badan}} \\
 &= 50 \text{ kg} \times 10 \text{ m/s}^2 & &= 0,6\% \times 500 \text{ N} \\
 &= 500 \text{ N} & &= 3 \text{ N} \\
 W_o &= \text{massa benda (kabinet)} \times g & F_{yw} &= W_o/2 + W_H \\
 &= 16,5 \text{ kg} \times 10 \text{ m/s}^2 & &= (165 \text{ N}/2) + 3 \text{ N} \\
 &= 165 \text{ N} & &= 85,5 \text{ N} \\
 & & M_w &= (W_o/2 + W_H) \times SL_1 \times \cos \theta_1 \\
 & & &= 85,5 \text{ N} \times 0,06 \times \cos 39,49^\circ \\
 & & &= 3,96 \text{ N}
 \end{aligned}$$

Lengan Bawah

$$\begin{aligned}
 \lambda_2 &= 43\% \\
 W_{LA} &= 1,7\% \times W_{\text{badan}} \\
 &= 1,7\% \times 500 \text{ N} \\
 &= 8,5 \text{ N} \\
 F_{ye} &= F_{yw} + W_{LA} \\
 &= 85,5 \text{ N} + 8,5 \text{ N} \\
 &= 94 \text{ N} \\
 M_e &= M_w + (W_{LA} \times \lambda_2 \times SL_2 \times \cos \theta_2) + (F_{yw} \times SL_2 \times \cos \theta_2) \\
 &= 3,96 \text{ Nm} + (8,5 \text{ N} \times 43\% \times 0,235 \text{ m} \times \cos 13,05^\circ) + (85,5 \text{ N} \times 0,235 \text{ m} \times \cos 13,05^\circ) \\
 &= 24,37 \text{ Nm}
 \end{aligned}$$

Lengan Atas

$$\begin{aligned}
 \lambda_3 &= 43,6\% \\
 W_{UA} &= 2,8\% \times W_{\text{badan}} \\
 &= 2,8\% \times 500 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 &= 14 \text{ N} \\
 F_{ys} &= F_{ye} + W_{UA} \\
 &= 94 \text{ N} + 14 \text{ N} \\
 &= 108 \text{ N} \\
 M_S &= M_e + (W_{UA} \times \lambda_3 \times SL_3 \times \cos \theta_3) + (F_{ye} \times SL_3 \times \cos \theta_3) \\
 &= 24,37 \text{ Nm} + (14 \text{ N} \times 43,6\% \times 0,225 \times \cos 69,38^\circ) + (94 \text{ N} \times 0,225 \text{ m} \times \cos 69,38^\circ) \\
 &= 32,30 \text{ Nm}
 \end{aligned}$$

Punggung

$$\begin{aligned}
 \lambda_4 &= 67\% \\
 W_T &= 50\% \times W_{\text{badan}} \\
 &= 50\% \times 500 \text{ N} \\
 &= 250 \text{ N} \\
 F_{yt} &= 2F_{ys} + W_T \\
 &= (2 \times 108 \text{ N}) + 250 \text{ N} \\
 &= 466 \text{ N} \\
 M_t &= 2M_s + (W_T \times \lambda_4 \times SL_4 \times \cos \theta_4) + (2F_{ys} \times SL_4 \times \cos \theta_4) \\
 &= (2 \times 32,30 \text{ Nm}) + (250 \text{ N} \times 67\% \times 0,435 \text{ m} \times \cos 88,83^\circ) + (2 \times 108 \text{ N} \times 0,435 \text{ m} \times \cos 88,83^\circ) \\
 &= 68,01 \text{ Nm}
 \end{aligned}$$

Total Gaya

$$\begin{aligned}
 W_{\text{tot}} &= W_o + 2 W_H + 2 W_{LA} + 2 W_{UA} + W_t \\
 &= 165 \text{ N} + (2 \times 3 \text{ N}) + (2 \times 8,5 \text{ N}) + (2 \times 14 \text{ N}) + 250 \text{ N} \\
 &= 466 \text{ N}
 \end{aligned}$$

Tekanan Perut (PA)

$$\begin{aligned}
 PA &= \frac{10^{-4} [43 - 0,360(\theta_H + \theta_T)]}{75} \left[\frac{M_{L5}}{SI} \right]^{1,8} \\
 &= \frac{10^{-4} [43 - 0,360(85,57^\circ + 77,31^\circ)]}{75} \left[\frac{M_{L5}}{SI} \right]^{1,8} \\
 &= 0,041 \text{ N/cm}^2
 \end{aligned}$$

$$\begin{aligned}
 F_A &= P_A \times A_A \\
 &= 0,041 \text{ N/cm}^2 \times 465 \text{ cm}^2 \\
 &= 19,28 \text{ N}
 \end{aligned}$$

Gaya Spinal Erector (F_M)

$$\begin{aligned}
 F_M &= \frac{M_{L5/S1} - F_A \cdot D}{E} \\
 &= \frac{68,01 \text{ Nm} - 19,8 \text{ N} \times 0,11}{0,05 \text{ m}} \\
 &= 1317,76 \text{ N}
 \end{aligned}$$

Gaya Tekan Pada L5/S1 (Force Compression/F_c)

$$\begin{aligned}
 F_c &= W_{tot} \cdot \cos \theta_4 + F_A + F_M \\
 &= (466 \text{ N} \times \cos 88,83^\circ) + 19,28 \text{ N} + 1317,76 \text{ N} \\
 &= 1346,56 \text{ N}
 \end{aligned}$$

Hasil akhir nilai F_c adalah sebesar 1346,56 N yang merupakan gaya tekan yang diterima oleh operator pada bagian L5/S1. Jika dibandingkan dengan nilai AL dan MPL maka nilai F_c ada dibawah nilai AL.

b. Perhitungan MPL Aktivitas Pengangkatan Manual Operator Mesin *Ban Saw*Telapak Tangan

$$\begin{aligned} W_{\text{badan}} &= \text{massa badan} \times g \\ &= 70 \text{ kg} \times 10 \text{ m/s}^2 \\ &= 700 \text{ N} \end{aligned}$$

$$\begin{aligned} W_H &= 0,6\% \times W_{\text{badan}} \\ &= 0,6\% \times 700 \text{ N} \\ &= 4,2 \text{ N} \end{aligned}$$

$$\begin{aligned} W_o &= \text{massa benda (kabinet)} \times g \\ &= 15 \text{ kg} \times 10 \text{ m/s}^2 \\ &= 150 \text{ N} \end{aligned}$$

$$\begin{aligned} F_{yw} &= W_o/2 + W_H \\ &= (150 \text{ N}/2) + 4,2 \text{ N} \\ &= 79,2 \text{ N} \end{aligned}$$

$$\begin{aligned} M_w &= (W_o/2 + W_H) \times SL_1 \times \cos \theta_1 \\ &= 79,2 \text{ N} \times 0,05 \times \cos 58,77^\circ \\ &= 2,05 \text{ Nm} \end{aligned}$$

Lengan Bawah

$$\lambda_2 = 43\%$$

$$\begin{aligned} W_{LA} &= 1,7\% \times W_{\text{badan}} \\ &= 1,7\% \times 700 \text{ N} \\ &= 11,9 \text{ N} \end{aligned}$$

$$\begin{aligned} F_{ye} &= F_{yw} + W_{LA} \\ &= 79,2 \text{ N} + 11,9 \text{ N} \\ &= 91,1 \text{ N} \end{aligned}$$

$$\begin{aligned} M_e &= M_w + (W_{LA} \times \lambda_2 \times SL_2 \times \cos \theta_2) + (F_{yw} \times SL_2 \times \cos \theta_2) \\ &= 2,05 \text{ Nm} + (11,9 \text{ N} \times 43\% \times 0,225 \text{ m} \times \cos 59,33^\circ) + (79,2 \text{ N} \times 0,225 \text{ m} \times \cos 59,33^\circ) \\ &= 11,73 \text{ Nm} \end{aligned}$$

Lengan Atas

$$\lambda_3 = 43,6\%$$

$$\begin{aligned} W_{UA} &= 2,8\% \times W_{\text{badan}} \\ &= 2,8\% \times 700 \text{ N} \\ &= 19,6 \text{ N} \end{aligned}$$

$$\begin{aligned} F_{ys} &= F_{ye} + W_{UA} \\ &= 91,1 \text{ N} + 19,6 \text{ N} \\ &= 110,7 \text{ N} \end{aligned}$$

$$\begin{aligned}
 M_S &= M_e + (W_{UA} \times \lambda_3 \times SL_3 \times \cos \theta_3) + (F_{ye} \times SL_3 \times \cos \theta_3) \\
 &= 11,73 \text{ Nm} + (19,6 \text{ N} \times 43,6\% \times 0,225 \times \cos 71,84^\circ) + (91,1 \text{ N} \times 0,225 \text{ m} \times \cos 71,84^\circ) \\
 &= 18,72 \text{ Nm}
 \end{aligned}$$

Punggung

$$\lambda_4 = 67\%$$

$$\begin{aligned}
 W_T &= 50\% \times W_{\text{badan}} \\
 &= 50\% \times 700 \text{ N} \\
 &= 350 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 F_{yt} &= 2F_{ys} + W_T \\
 &= (2 \times 110,7 \text{ N}) + 350 \text{ N} \\
 &= 571,4 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 M_t &= 2M_s + (W_T \times \lambda_4 \times SL_4 \times \cos \theta_4) + (2F_{ys} \times SL_4 \times \cos \theta_4) \\
 &= (2 \times 18,72 \text{ Nm}) + (350 \text{ N} \times 67\% \times 0,425 \text{ m} \times \cos 7,09^\circ) + (2 \times 110,7 \text{ N} \times 0,425 \text{ m} \times \cos 7,09^\circ) \\
 &= 229,71 \text{ Nm}
 \end{aligned}$$

Total Gaya

$$\begin{aligned}
 W_{\text{tot}} &= W_o + 2 W_H + 2 W_{LA} + 2 W_{UA} + W_t \\
 &= 150 \text{ N} + (2 \times 4,2 \text{ N}) + (2 \times 11,9 \text{ N}) + (2 \times 19,6 \text{ N}) + 350 \text{ N} \\
 &= 571,4 \text{ N}
 \end{aligned}$$

Tekanan Perut (PA)

$$\begin{aligned}
 PA &= \frac{10^{-4} [43 - 0,360(\theta_H + \theta_T)]}{75} \left[\frac{M_{L5}^{1,8}}{SI} \right] \\
 &= \frac{10^{-4} [43 - 0,360(18,59^\circ + 80,84^\circ)]}{75} \left[\frac{M_{L5}^{1,8}}{SI} \right]
 \end{aligned}$$

$$= 0,171 \text{ N/cm}^2$$

$$FA = PA \times AA$$

$$= 0,171 \text{ N/cm}^2 \times 465 \text{ cm}^2$$

$$= 79,46 \text{ N}$$

Gaya Spinal Erector (Fm)

$$\begin{aligned}
 F_M &= \frac{M_{L5/S1} - F_A \cdot D}{E} \\
 &= \frac{229,71 \text{ Nm} - 19,8 \text{ N} \times 0,11}{0,05 \text{ m}} \\
 &= 4419,42 \text{ N}
 \end{aligned}$$

Gaya Tekan Pada L5/S1 (Force Compression/Fc)

$$\begin{aligned}
 F_c &= W_{tot} \cdot \cos \theta_4 + F_A + F_M \\
 &= (571,4 \text{ N} \times \cos 7,09^\circ) + 79,46 \text{ N} + 4419,42 \text{ N} \\
 &= 4906,99 \text{ N}
 \end{aligned}$$

Hasil akhir nilai F_c adalah sebesar 4806,99 N yang merupakan gaya tekan yang diterima oleh operator pada bagian L5/S1. Jika dibandingkan dengan nilai AL dan MPL maka nilai F_c ada diantara nilai AL dan nilai MPL.

c. Perhitungan MPL Aktivitas Pengangkatan Menggunakan Alat *Manual Handlift*
Operator Mesin *Ban Saw*

Telapak Tangan

$$\begin{aligned} W_{\text{badan}} &= \text{massa badan} \times g \\ &= 70 \text{ kg} \times 10 \text{ m/s}^2 \\ &= 700 \text{ N} \end{aligned}$$

$$\begin{aligned} W_H &= 0,6\% \times W_{\text{badan}} \\ &= 0,6\% \times 700 \text{ N} \\ &= 4,2 \text{ N} \end{aligned}$$

$$\begin{aligned} W_o &= \text{massa benda (kabinet)} \times g \\ &= 15 \text{ kg} \times 10 \text{ m/s}^2 \\ &= 150 \text{ N} \end{aligned}$$

$$\begin{aligned} F_{yw} &= W_o/2 + W_H \\ &= (150 \text{ N}/2) + 4,2 \text{ N} \\ &= 79,2 \text{ N} \end{aligned}$$

$$\begin{aligned} M_w &= (W_o/2 + W_H) \times SL_1 \times \cos \theta_1 \\ &= 79,2 \text{ N} \times 0,05 \times \cos 61,48^\circ \\ &= 0,19 \text{ Nm} \end{aligned}$$

Lengan Bawah

$$\lambda_2 = 43\%$$

$$\begin{aligned} W_{LA} &= 1,7\% \times W_{\text{badan}} \\ &= 1,7\% \times 700 \text{ N} \\ &= 11,9 \text{ N} \end{aligned}$$

$$\begin{aligned} F_{ye} &= F_{yw} + W_{LA} \\ &= 79,2 \text{ N} + 11,9 \text{ N} \\ &= 91,1 \text{ N} \end{aligned}$$

$$\begin{aligned} M_e &= M_w + (W_{LA} \times \lambda_2 \times SL_2 \times \cos \theta_2) + (F_{yw} \times SL_2 \times \cos \theta_2) \\ &= 0,19 \text{ Nm} + (11,9 \text{ N} \times 43\% \times 0,225 \text{ m} \times \cos 26,09^\circ) + (79,2 \text{ N} \times 0,225 \text{ m} \times \cos 26,09^\circ) \\ &= 17,23 \text{ Nm} \end{aligned}$$

Lengan Atas

$$\lambda_3 = 43,6\%$$

$$\begin{aligned} W_{UA} &= 2,8\% \times W_{\text{badan}} \\ &= 2,8\% \times 700 \text{ N} \\ &= 19,6 \text{ N} \end{aligned}$$

$$\begin{aligned}
 F_{ys} &= F_{ye} + W_{UA} \\
 &= 91,1 \text{ N} + 19,6 \text{ N} \\
 &= 110,7 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 M_S &= M_e + (W_{UA} \times \lambda_3 \times SL_3 \times \cos \theta_3) + (F_{ye} \times SL_3 \times \cos \theta_3) \\
 &= 17,23 \text{ Nm} + (19,6 \text{ N} \times 43,6\% \times 0,225 \times \cos 89,99^\circ) + (91,1 \text{ N} \times 0,225 \text{ m} \times \cos \\
 &\quad 89,99^\circ) \\
 &= 17,23 \text{ Nm}
 \end{aligned}$$

Punggung

$$\lambda_4 = 67\%$$

$$\begin{aligned}
 W_T &= 50\% \times W_{\text{badan}} \\
 &= 50\% \times 700 \text{ N} \\
 &= 350 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 F_{yt} &= 2F_{ys} + W_T \\
 &= (2 \times 110,7 \text{ N}) + 350 \text{ N} \\
 &= 571,4 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 M_t &= 2M_s + (W_T \times \lambda_4 \times SL_4 \times \cos \theta_4) + (2F_{ys} \times SL_4 \times \cos \theta_4) \\
 &= (2 \times 17,23 \text{ Nm}) + (350 \text{ N} \times 67\% \times 0,425 \text{ m} \times \cos 71,11^\circ) + (2 \times 110,7 \text{ N} \times \\
 &\quad 0,425 \text{ m} \times \cos 71,11^\circ) \\
 &= 97,19 \text{ Nm}
 \end{aligned}$$

Total Gaya

$$\begin{aligned}
 W_{\text{tot}} &= W_o + 2 W_H + 2 W_{LA} + 2 W_{UA} + W_t \\
 &= 150 \text{ N} + (2 \times 4,2 \text{ N}) + (2 \times 11,9 \text{ N}) + (2 \times 19,6 \text{ N}) + 350 \text{ N} \\
 &= 571,4 \text{ N}
 \end{aligned}$$

Tekanan Perut (PA)

$$\begin{aligned}
 PA &= \frac{10^{-4} [43 - 0,360(\theta_H + \theta_T)]}{75} \left[\frac{M_{L_5}^{1,8}}{S_1} \right] \\
 &= \frac{10^{-4} [43 - 0,360(78,76^\circ + 70,65^\circ)]}{75} \left[\frac{M_{L_5}^{1,8}}{S_1} \right] \\
 &= 0,19 \text{ N/cm}^2
 \end{aligned}$$

$$\begin{aligned}
 F_A &= P_A \times A_A \\
 &= 0,19 \text{ N/cm}^2 \times 465 \text{ cm}^2 \\
 &= 25,30 \text{ N}
 \end{aligned}$$

Gaya Spinal Erector (F_M)

$$\begin{aligned}
 F_M &= \frac{M_{L5/S1} - F_A \cdot D}{E} \\
 &= \frac{97,19 \text{ Nm} - 19,8 \text{ N} \times 0,11}{0,05 \text{ m}} \\
 &= 1888,19 \text{ N}
 \end{aligned}$$

Gaya Tekan Pada L5/S1 (Force Compression/F_c)

$$\begin{aligned}
 F_c &= W_{tot} \cdot \cos \theta_4 + F_A + F_M \\
 &= (571,4 \text{ N} \times \cos 71,11^\circ) + 25,30 \text{ N} + 1888,19 \text{ N} \\
 &= 2047,88 \text{ N}
 \end{aligned}$$

Hasil akhir nilai F_c adalah sebesar 2047,88 N yang merupakan gaya tekan yang diterima oleh operator pada bagian L5/S1. Jika dibandingkan dengan nilai AL dan MPL maka nilai F_c ada dibawah nilai AL.

LAMPIRAN 4

Perhitungan Metode RWL (*Recommended Weight Limit*)

- a. Perhitungan RWL Aktivitas Pengangkatan Menggunakan Alat *Automatic Handlift* Operator Mesin *Double Sizer*

RWL Origin

$$LC = 23 \text{ kg}$$

$$L = 16,5 \text{ kg}$$

$$V = 80 \text{ cm}$$

$$D = V_{origin} - V_{destination} = 13 \text{ cm}$$

$$H = 20 \text{ cm}$$

$$A = 30^\circ$$

$$HM = \frac{25}{H} = \frac{25}{20} = 1,25$$

$$VM = 1 - 0,00326 |V - 75| = 1 - 0,00326 |80 - 75| = 0,98$$

$$DM = 0,82 + \frac{4,5}{D} = 0,82 + \frac{4,5}{13} = 1,17$$

$$FM = 3 \text{ angkatan/menit (berdasarkan tabel Frekuensi nilai yang didapat adalah 0,55)}$$

$$AM = 1 - 0,0032A = 1 - (0,0032 \times 30) = 0,90$$

$$CM = 0,90 \text{ (berdasarkan table coupling, dengan tipe coupling : poor)}$$

$$LC = 23$$

Sehingga:

$$\begin{aligned} RWL &= LC \times HM \times VM \times DM \times AM \times FM \times CM \\ &= 23 \times 1,25 \times 0,98 \times 1,17 \times 0,90 \times 0,55 \times 0,90 \\ &= 14,76 \text{ kg} \end{aligned}$$

Kemudian menghitung nilai *Lifting Index* (LI)

$$LI = \frac{L}{RWL} = \frac{16,5 \text{ kg}}{14,76 \text{ kg}} = 1,12$$

RWL Destination

$$LC = 23 \text{ kg}$$

$$L = 16,5 \text{ kg}$$

$$V = 93 \text{ cm}$$

$$D = V_{origin} - V_{destination} = 13 \text{ cm}$$

$$H = 16 \text{ cm}$$

$$A = 30^\circ$$

$$HM = \frac{25}{H} = \frac{25}{16} = 1,56$$

$$VM = 1 - 0,00326 |V - 75| = 1 - 0,00326 |93 - 75| = 0,94$$

$$DM = 0,82 + \frac{4,5}{D} = 0,82 + \frac{4,5}{13} = 1,17$$

FM = 3 angkatan/menit (berdasarkan tabel Frekuensi nilai yang didapat adalah 0,55)

$$AM = 1 - 0,0032A = 1 - (0,0032 \times 30) = 0,90$$

CM = 0,95 (berdasarkan table *coupling*, dengan tipe *coupling* : *poor*)

$$LC = 23$$

Sehingga:

$$\begin{aligned} RWL &= LC \times HM \times VM \times DM \times AM \times FM \times CM \\ &= 23 \times 1,56 \times 0,94 \times 1,17 \times 0,90 \times 0,55 \times 0,95 \\ &= 18,63 \text{ kg} \end{aligned}$$

Kemudian menghitung nilai *Lifting Index* (LI)

$$LI = \frac{L}{RWL} = \frac{16,5 \text{ kg}}{18,63 \text{ kg}} = 0,89$$

Berdasarkan perhitungan RWL pada kondisi *origin* didapatkan nilai RWL sebesar 14,76 kg dan nilai LI sebesar 1,12. Sedangkan pada kondisi *destination* didapatkan nilai RWL sebesar 18,63 kg dan nilai LI sebesar 0,89.

b. Perhitungan RWL Aktivitas Pengangkatan Manual Operator Mesin *Ban Saw*

RWL Origin

$$LC = 23 \text{ kg}$$

$$L = 15 \text{ kg}$$

$$V = 12 \text{ cm}$$

$$D = V_{origin} - V_{destination} = 71 \text{ cm}$$

$$H = 20 \text{ cm}$$

$$A = 15^\circ$$

$$HM = \frac{25}{H} = \frac{25}{20} = 1,25$$

$$VM = 1 - 0,00326 |V - 75| = 1 - 0,00326 |12 - 75| = 0,79$$

$$DM = 0,82 + \frac{4,5}{D} = 0,82 + \frac{4,5}{71} = 0,88$$

$$FM = 0,85 \text{ (Frekuensi pengangkatan kurang atau hanya 1 kali dalam 5 menit)} \\ \text{ditetapkan } F = 0,2 \text{ angkatan/menit)}$$

$$AM = 1 - 0,0032A = 1 - (0,0032 \times 15) = 0,95$$

$$CM = 0,90 \text{ (berdasarkan table } coupling, \text{ dengan tipe } copling : poor)$$

$$LC = 23$$

Sehingga:

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM \\ = 23 \times 1,25 \times 0,79 \times 0,88 \times 0,95 \times 0,85 \times 0,90 \\ = 14,70 \text{ kg}$$

Kemudian menghitung nilai *Lifting Index* (LI)

$$LI = \frac{L}{RWL} = \frac{15 \text{ kg}}{14,70 \text{ kg}} = 1,02$$

RWL Destination

$$LC = 23 \text{ kg}$$

$$L = 15 \text{ kg}$$

$$V = 83 \text{ cm}$$

$$D = V_{origin} - V_{destination} = 71 \text{ cm}$$

$$H = 17 \text{ cm}$$

$$A = 15^\circ$$

$$HM = \frac{25}{H} = \frac{25}{17} = 1,47$$

$$VM = 1 - 0,00326 |V - 75| = 1 - 0,00326 |83 - 75| = 0,97$$

$$DM = 0,82 + \frac{4,5}{D} = 0,82 + \frac{4,5}{71} = 0,88$$

$$FM = 0,85 \text{ (Frekuensi pengangkatan kurang atau hanya 1 kali dalam 5 menit)} \\ \text{ditetapkan } F = 0,2 \text{ angkatan/menit)}$$

$$AM = 1 - 0,0032A = 1 - (0,0032 \times 15) = 0,95$$

$$CM = 0,95 \text{ (berdasarkan table } coupling, \text{ dengan tipe } copling : poor)$$

$$LC = 23$$

Sehingga:

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM \\ = 23 \times 1,47 \times 0,97 \times 0,88 \times 0,95 \times 0,85 \times 0,95 \\ = 22,37 \text{ kg}$$

Kemudian menghitung nilai *Lifting Index* (LI)

$$LI = \frac{L}{RWL} = \frac{15 \text{ kg}}{22,37 \text{ kg}} = 0,67$$

Berdasarkan perhitungan RWL pada kondisi *origin* didapatkan nilai RWL sebesar 14,70 kg dan nilai LI sebesar 1,02. Sedangkan pada kondisi *destination* didapatkan nilai RWL sebesar 22,37 kg dan nilai LI sebesar 0,67.

- c. Perhitungan RWL Aktivitas Pengangkatan Menggunakan Alat *Manual Handlift* Operator Mesin *Ban Saw*

RWL Origin

$$LC = 23 \text{ kg}$$

$$V = 60 \text{ cm}$$

$$H = 20 \text{ cm}$$

$$L = 15 \text{ kg}$$

$$D = V_{origin} - V_{destination} = 23 \text{ cm}$$

$$A = 15^\circ$$

$$HM = \frac{25}{H} = \frac{25}{20} = 1,25$$

$$VM = 1 - 0,00326 |V - 75| = 1 - 0,00326 |60 - 75| = 0,95$$

$$DM = 0,82 + \frac{4,5}{D} = 0,82 + \frac{4,5}{23} = 1,02$$

$$FM = 0,85 \text{ (Frekuensi pengangkatan kurang atau hanya 1 kali dalam 5 menit ditetapkan } F = 0,2 \text{ angkatan/menit)}$$

$$AM = 1 - 0,0032A = 1 - (0,0032 \times 15) = 0,95$$

$$CM = 0,90 \text{ (berdasarkan table } coupling, \text{ dengan tipe } coupling : poor)$$

$$LC = 23$$

Sehingga:

$$\begin{aligned} RWL &= LC \times HM \times VM \times DM \times AM \times FM \times CM \\ &= 23 \times 1,25 \times 0,95 \times 1,02 \times 0,95 \times 0,85 \times 0,90 \\ &= 20,23 \text{ kg} \end{aligned}$$

Kemudian menghitung nilai *Lifting Index* (LI)

$$LI = \frac{L}{RWL} = \frac{15 \text{ kg}}{20,23 \text{ kg}} = 0,74$$

RWL Destination

$$LC = 23 \text{ kg}$$

$$V = 83 \text{ cm}$$

$$H = 17 \text{ cm}$$

$$L = 15 \text{ kg}$$

$$D = V_{origin} - V_{destination} = 23 \text{ cm}$$

$$A = 15^\circ$$

$$HM = \frac{25}{H} = \frac{25}{17} = 1,47$$

$$VM = 1 - 0,00326 |V - 75| = 1 - 0,00326 |83 - 75| = 0,97$$

$$DM = 0,82 + \frac{4,5}{D} = 0,82 + \frac{4,5}{23} = 1,02$$

$$FM = 0,85 \text{ (Frekuensi pengangkatan kurang atau hanya 1 kali dalam 5 menit ditetapkan } F = 0,2 \text{ angkatan/menit)}$$

$$AM = 1 - 0,0032A = 1 - (0,0032 \times 15) = 0,95$$

$$CM = 0,95 \text{ (berdasarkan table } coupling, \text{ dengan tipe } coupling : poor)$$

$$LC = 23$$

Sehingga:

$$\begin{aligned} RWL &= LC \times HM \times VM \times DM \times AM \times FM \times CM \\ &= 23 \times 1,47 \times 0,97 \times 1,02 \times 0,95 \times 0,85 \times 0,95 \\ &= 25,72 \text{ kg} \end{aligned}$$

Kemudian menghitung nilai *Lifting Index* (LI)

$$LI = \frac{L}{RWL} = \frac{15 \text{ kg}}{25,72} = 0,58$$

Berdasarkan perhitungan RWL pada kondisi *origin* didapatkan nilai RWL sebesar 20,23 kg dan nilai LI sebesar 0,74. Sedangkan pada kondisi *destination* didapatkan nilai RWL sebesar 25,72 kg dan nilai LI sebesar 0,58.

LAMPIRAN 5

Data Waktu Proses

a. Data Waktu Proses Kabinet *Side Arm* (Operator Mesin *Double Sizer*)

Manual

Elemen Kerja		Pengamatan									
		1	2	3	4	5	6	7	8	9	10
Mengangkat kabinet	Detik	10,21	11,4	10,53	10,51	11,21	10,31	11,47	10,3	10,72	10,62
	Menit	0,17	0,19	0,18	0,18	0,19	0,17	0,19	0,17	0,18	0,18
Memasukkan kabinet ke mesin	Detik	10,55	10,15	10,51	10,76	11,65	11,6	10,54	7,89	9,54	9,38
	Menit	0,18	0,17	0,18	0,18	0,19	0,19	0,18	0,13	0,16	0,16

Handlift

Elemen Kerja		Pengamatan									
		1	2	3	4	5	6	7	8	9	10
Mengangkat kabinet	Detik	4,78	5,84	4,42	4,51	6,73	5,76	5,38	4,82	5,51	5,45
	Menit	0,08	0,10	0,07	0,08	0,11	0,10	0,09	0,08	0,09	0,09
Memasukkan kabinet ke mesin	Detik	10,55	10,15	10,51	10,76	11,65	11,6	10,54	7,89	9,54	9,38
	Menit	0,18	0,17	0,18	0,18	0,19	0,19	0,18	0,13	0,16	0,16

b. Data Operator Mesin *Ban Saw*

Untuk menghitung produktivitas operator mesin *Ban Saw* pada saat melakukan pekerjaannya menggunakan alat *Manual Handlift* atau pun secara manual maka dibutuhkan data *standar time* (ST) dari operator tersebut sebagai input dalam perhitungan produktivitas. Berikut ini merupakan data *standar time* (ST) operator mesin *Ban Saw* ketika melakukan pekerjaan menggunakan alat *Manual Handlift*.

Manual B1/B2

Elemen Kerja		Pengamatan									
		1	2	3	4	5	6	7	8	9	10
Mengangkat kabinet	Detik	13,67	8,27	7,75	12,45	12,43	11,6	13,5	12,76	11,54	9,78
	Menit	0,23	0,14	0,13	0,21	0,21	0,19	0,23	0,21	0,19	0,16
Menggambar	Detik	18,29	20,26	19,80	18,35	19,21	18,37	18,62	20,07	19,49	18,35
	Menit	0,30	0,34	0,33	0,31	0,32	0,31	0,31	0,33	0,32	0,31
Potong Treble	Detik	94,32	92,21	104,08	92,69	96,92	101,07	100,79	92,65	93,78	98,51
	Menit	1,57	1,54	1,73	1,54	1,62	1,68	1,68	1,54	1,56	1,64
Simpan treble	Detik	12,1	11,45	12,6	10,57	12,1	10,7	11,7	10,7	12,34	12,27
	Menit	0,20	0,19	0,21	0,18	0,20	0,18	0,20	0,18	0,21	0,20

Manual B3

Elemen Kerja		Pengamatan									
		1	2	3	4	5	6	7	8	9	10
Mengangkat kabinet	Detik	13,67	8,27	7,75	12,45	12,43	11,6	13,5	12,76	11,54	9,78
	Menit	0,23	0,14	0,13	0,21	0,21	0,19	0,23	0,21	0,19	0,16
Menggambar	Detik	22,31	20,54	21,08	21,06	21,81	21,07	22,54	21,31	22,05	21,06
	Menit	0,37	0,34	0,35	0,35	0,36	0,35	0,38	0,36	0,37	0,35
Potong Treble	Detik	79,43	84,56	87,57	92,93	79,43	97,89	85,93	81,26	88,80	95,57
	Menit	1,32	1,41	1,46	1,55	1,32	1,63	1,43	1,35	1,48	1,59
Simpan treble	Detik	12,1	11,45	12,6	10,57	12,1	10,7	11,7	10,7	12,34	12,27
	Menit	0,20	0,19	0,21	0,18	0,20	0,18	0,20	0,18	0,21	0,20

Menggunakan *Manual Handlift* B1/B2

Elemen Kerja		Pengamatan									
		1	2	3	4	5	6	7	8	9	10
Mengangkat kabinet	Detik	5,73	5,59	5,26	5,14	5,56	6,59	5,58	6,58	5,41	4,87
	Menit	0,10	0,09	0,09	0,09	0,09	0,11	0,09	0,11	0,09	0,08
Menggambar	Detik	18,29	20,26	19,80	18,35	19,21	18,37	18,62	20,07	19,49	18,35
	Menit	0,30	0,34	0,33	0,31	0,32	0,31	0,31	0,33	0,32	0,31
Potong Treble	Detik	94,32	92,21	104,08	92,69	96,92	101,07	100,79	92,65	93,78	98,51
	Menit	1,57	1,54	1,73	1,54	1,62	1,68	1,68	1,54	1,56	1,64
Simpan treble	Detik	12,10	11,45	12,60	10,57	12,10	10,70	11,70	10,70	12,34	12,27
	Menit	0,20	0,19	0,21	0,18	0,20	0,18	0,20	0,18	0,21	0,20

Menggunakan *Manual Handlift* B3

Elemen Kerja		Pengamatan									
		1	2	3	4	5	6	7	8	9	10
Mengangkat kabinet	Detik	5,73	5,59	5,26	5,14	5,56	6,59	5,58	6,58	5,41	4,87
	Menit	0,10	0,09	0,09	0,09	0,09	0,11	0,09	0,11	0,09	0,08
Menggambar	Detik	22,31	20,54	21,08	21,06	21,81	21,07	22,54	21,31	22,05	21,06
	Menit	0,37	0,34	0,35	0,35	0,36	0,35	0,38	0,36	0,37	0,35
Potong Treble	Detik	79,43	84,56	87,57	92,93	79,43	97,89	85,93	81,26	88,80	95,57
	Menit	1,32	1,41	1,46	1,55	1,32	1,63	1,43	1,35	1,48	1,59
Simpan treble	Detik	12,10	11,45	12,60	10,57	12,10	10,70	11,70	10,70	12,34	12,27
	Menit	0,20	0,19	0,21	0,18	0,20	0,18	0,20	0,18	0,21	0,20

LAMPIRAN 6

Perhitungan Produktivitas

a. Perhitungan Produktivitas Operator Mesin *Double Sizer*

Perhitungan Produktivitas Bulan September 2015

Tanggal	Model	ST	Output Awal	Total Jam Kerja (Menit)	Output (Unit)	Produktivitas
1	B1	0,35	42	38,82	28	3,47
	B2	0,35	36			
	B3	0,35	21			
	U1J	0,35	12			
2	B1	0,35	0	13,99	10	1,25
	B2	0,35	0			
	B3	0,35	25			
	U1J	0,35	15			
3	B1	0,35	56	44,94	32	4,02
	B2	0,35	40			
	B3	0,35	18			
	U1J	0,35	15			
4	B1	0,35	10	19,94	14	1,78
	B2	0,35	15			
	B3	0,35	20			
	U1J	0,35	12			
7	B1	0,35	52	42,14	30	3,77
	B2	0,35	36			
	B3	0,35	18			
	U1J	0,35	15			
8	B1	0,35	45	36,72	26	3,28
	B2	0,35	0			
	B3	0,35	25			
	U1J	0,35	35			
9	B1	0,35	12	18,89	14	1,69
	B2	0,35	6			
	B3	0,35	21			
	U1J	0,35	15			
10	B1	0,35	32	35,32	25	3,16
	B2	0,35	36			
	B3	0,35	21			
	U1J	0,35	12			
11	B1	0,35	36	48,62	35	4,34
	B2	0,35	21			
	B3	0,35	12			
	U1J	0,35	70			
14	B1	0,35	0	12,59	9	1,13
	B2	0,35	21			
	B3	0,35	15			
	U1J	0,35	0			
15	B1	0,35	42	34,45	25	3,08
	B2	0,35	24			
	B3	0,35	18			
	U1J	0,35	15			
16	B1	0,35	42	23,08	17	2,06

Tanggal	Model	ST	Output Awal	Total Jam Kerja (Menit)	Output (Unit)	Produktivitas
17	B2	0,35	24	48,27	35	4,31
	B3	0,35	0			
	U1J	0,35	0			
	B1	0,35	42			
	B2	0,35	36			
18	B3	0,35	25	27,28	20	2,44
	U1J	0,35	35			
	B1	0,35	42			
	B2	0,35	36			
	B3	0,35	0			
21	U1J	0,35	0	38,65	28	3,45
	B1	0,35	42			
	B2	0,35	36			
	B3	0,35	18			
22	U1J	0,35	15	38,65	28	3,45
	B1	0,35	42			
	B2	0,35	36			
	B3	0,35	18			
23	U1J	0,35	15	49,31	35	4,41
	B1	0,35	65			
	B2	0,35	36			
	B3	0,35	25			
24	U1J	0,35	15	45,12	32	4,03
	B1	0,35	57			
	B2	0,35	36			
	B3	0,35	21			
25	U1J	0,35	15	18,89	14	1,69
	B1	0,35	70			
	B2	0,35	6			
	B3	0,35	21			
28	U1J	0,35	15	37,07	27	3,31
	B1	0,35	65			
	B2	0,35	0			
	B3	0,35	21			
29	U1J	0,35	15	49,31	35	4,41
	B1	0,35	40			
	B2	0,35	36			
	B3	0,35	25			
30	U1J	0,35	12	30,43	22	2,72
	B2	0,35	15			
	B3	0,35	20			
Rata-rata						3,06

Perhitungan Produktivitas Bulan Oktober 2015

Tanggal	Model	ST	Output Awal	Total Jam Kerja (Menit)	Output (Unit)	Produktivitas
1	B1	0,26	45	29,86	29	3,59
	B2	0,26	40			
	B3	0,26	15			
	U1J	0,26	15			
2	B1	0,26	45	27,26	26	3,28
	B2	0,26	32			
	B3	0,26	18			
	U1J	0,26	10			
5	B1	0,26	45	25,44	25	3,06
	B2	0,26	28			
	B3	0,26	15			
	U1J	0,26	10			
6	B1	0,26	45	18,17	18	2,19
	B2	0,26	0			
	B3	0,26	15			
	U1J	0,26	10			
7	B1	0,26	45	28,56	28	3,44
	B2	0,26	40			
	B3	0,26	15			
	U1J	0,26	10			
8	B1	0,26	45	18,17	18	2,19
	B2	0,26	0			
	B3	0,26	15			
	U1J	0,26	10			
9	B1	0,26	45	29,34	28	3,53
	B2	0,26	40			
	B3	0,26	18			
	U1J	0,26	10			
12	B1	0,26	87	48,29	47	5,81
	B2	0,26	66			
	B3	0,26	18			
	U1J	0,26	15			
13	B1	0,26	116	48,55	47	5,84
	B2	0,26	46			
	B3	0,26	15			
	U1J	0,26	10			
14	B1	0,26	0	9,35	9	1,13
	B2	0,26	21			
	B3	0,26	15			
	U1J	0,26	0			
15	B1	0,26	53	30,63	30	3,69

Tanggal	Model	ST	Output Awal	Total Jam Kerja (Menit)	Output (Unit)	Produktivitas
	B2	0,26	40			
	B3	0,26	15			
	U1J	0,26	10			
	B1	0,26	21			
16	B2	0,26	15	22,33	22	2,69
	B3	0,26	25			
	U1J	0,26	25			
	B1	0,26	85			
19	B2	0,26	60	42,84	41	5,16
	B3	0,26	0			
	U1J	0,26	20			
	B1	0,26	56			
20	B2	0,26	36	30,38	29	3,66
	B3	0,26	0			
	U1J	0,26	25			
	B1	0,26	0			
21	B2	0,26	24	10,77	10	1,30
	B3	0,26	0			
	U1J	0,26	18			
	B1	0,26	0			
22	B2	0,26	48	12,46	12	1,50
	B3	0,26	0			
	U1J	0,26	0			
	B1	0,26	108			
23	B2	0,26	12	31,15	30	3,75
	B3	0,26	0			
	U1J	0,26	0			
	B1	0,26	32			
26	B2	0,26	21	18,04	17	2,17
	B3	0,26	12			
	U1J	0,26	5			
	P121	0,26	45			
27	B2	0,26	40	29,34	28	3,53
	B3	0,26	18			
	U1J	0,26	10			
	B1	0,26	0			
28	B2	0,26	80	29,34	28	3,53
	B3	0,26	18			
	U1J	0,26	15			
	B1	0,26	65			
29	B2	0,26	36	36,61	35	4,41
	B3	0,26	25			

Tanggal	Model	ST	Output Awal	Total Jam Kerja (Menit)	Output (Unit)	Produktivitas
30	UIJ	0,26	15	29,34	28	3,53
	B1	0,26	40			
	B2	0,26	40			
	B3	0,26	18			
	UIJ	0,26	15			
Rata-rata						3,32

b. Perhitungan Produktivitas Operator Mesin *Ban Saw*

Perhitungan Produktivitas Bulan September 2016

Tanggal	Model	ST	Ouput Awal	Total Jam Kerja (Menit)	Ouput (Unit)	Produktivitas
01/09/2016	B1	2,31	43	215,95	32	9,86
	B2	2,31	19			
	B3	2,20	33			
02/09/2016	B1	2,31	37	114,40	17	5,22
	B2	2,31	2			
	B3	2,20	11			
05/09/2016	B1	2,31	42	228,45	33	10,43
	B2	2,31	33			
	B3	2,20	25			
06/09/2016	B1	2,31	47	228,80	34	10,44
	B2	2,31	31			
	B3	2,20	22			
07/09/2016	B1	2,31	4	217,00	32	9,90
	B2	2,31	67			
	B3	2,20	24			
08/09/2016	B1	2,31	5	216,65	32	9,89
	B2	2,31	63			
	B3	2,20	27			
09/09/2016	B1	2,31	30	183,34	27	8,37
	B2	2,31	35			
	B3	2,20	15			
13/09/2016	B1	2,31	36	241,75	35	11,03
	B2	2,31	40			
	B3	2,20	30			
14/09/2016	B1	2,31	39	228,45	33	10,43
	B2	2,31	36			
	B3	2,20	25			
15/09/2016	B1	2,31	41	229,03	34	10,45
	B2	2,31	39			
	B3	2,20	20			
16/09/2016	B1	2,31	73	282,01	41	12,87
	B2	2,31	28			
	B3	2,20	22			
19/09/2016	B1	2,31	44	182,18	27	8,31
	B2	2,31	11			
	B3	2,20	25			
20/09/2016	B1	2,31	53	158,12	23	7,22

Tanggal	Model	ST	Ouput Awal	Total Jam Kerja (Menit)	Ouput (Unit)	Produktivitas
21/09/2016	B2	2,31	3	219,78	32	10,03
	B3	2,20	13			
	B2	2,31	38			
22/09/2016	B2	2,31	57	205,20	30	9,36
	B3	2,20	0			
	B1	2,31	44			
23/09/2016	B2	2,31	20	160,32	23	7,32
	B3	2,20	26			
	B1	2,31	43			
26/09/2016	B2	2,31	13	206,13	30	9,41
	B3	2,20	14			
	B1	2,31	33			
27/09/2016	B2	2,31	39	204,97	30	9,35
	B3	2,20	18			
	B1	2,31	58			
28/09/2016	B2	2,31	23	191,55	28	8,74
	B3	2,20	8			
	B1	2,31	35			
29/09/2016	B2	2,31	25	168,30	25	7,68
	B3	2,20	24			
	B1	2,31	49			
Rata-rata						8,79

Perhitungan Produktivitas Bulan Oktober 2016

Tanggal	Model	ST (Menit)	Ouput Awal	Total Jam Kerja (Menit)	Ouput (Unit)	Produktivitas
03/10/2016	B1	2,22	28	120,47	18	5,74
	B2	2,22	14			
	B3	2,10	13			
04/10/2016	B1	2,22	56	207,31	32	9,88
	B2	2,22	28			
	B3	2,10	10			
05/10/2016	B1	2,22	33	174,64	27	8,32
	B2	2,22	23			
	B3	2,10	24			
06/10/2016	B1	2,22	62	171,59	26	8,17
	B2	2,22	4			
	B3	2,10	12			
07/10/2016	B1	2,22	44	141,72	22	6,75
	B2	2,22	0			
	B3	2,10	21			
10/10/2016	B1	2,22	41	132,96	20	6,33
	B2	2,22	0			
	B3	2,10	20			
11/10/2016	B1	2,22	30	174,29	27	8,30
	B2	2,22	23			
	B3	2,10	27			
12/10/2016	B1	2,22	34	158,76	24	7,56
	B2	2,22	12			
	B3	2,10	27			

Tanggal	Model	ST (Menit)	Ouput Awal	Total Jam Kerja (Menit)	Ouput (Unit)	Produktivitas
13/10/2016	B1	2,22	19	161,21	25	7,68
	B2	2,22	30			
	B3	2,10	25			
14/10/2016	B1	2,22	47	222,73	34	10,61
	B2	2,22	25			
	B3	2,10	30			
17/10/2016	B1	2,22	24	163,55	25	7,79
	B2	2,22	27			
	B3	2,10	24			
18/10/2016	B1	2,22	43	207,79	32	9,90
	B2	2,22	27			
	B3	2,10	25			
19/10/2016	B1	2,22	40	219,69	34	10,47
	B2	2,22	42			
	B3	2,10	18			
20/10/2016	B1	2,22	37	218,29	33	10,40
	B2	2,22	33			
	B3	2,10	30			
21/10/2016	B1	2,22	38	164,24	25	7,82
	B2	2,22	19			
	B3	2,10	18			
24/10/2016	B1	2,22	48	209,18	32	9,97
	B2	2,22	34			
	B3	2,10	13			
25/10/2016	B1	2,22	42	219,57	34	10,46
	B2	2,22	39			
	B3	2,10	19			
26/10/2016	B1	2,22	34	176,26	27	8,40
	B2	2,22	36			
	B3	2,10	10			
27/10/2016	B1	2,22	49	220,27	34	10,49
	B2	2,22	38			
	B3	2,10	13			
28/10/2016	B1	2,22	34	176,03	27	8,39
	B2	2,22	34			
	B3	2,10	12			
31/10/2016	B1	2,22	44	175,91	27	8,38
	B2	2,22	23			
	B3	2,10	13			
Rata-rata						9,18

LAMPIRAN 7

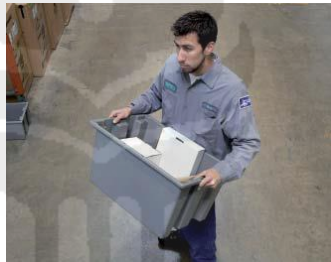
Contoh SOP Untuk Pekerjaan Yang Melibatkan Aktivitas Pengangkatan

Sumber : (Center for Disease Control and Prevention, 2007)

1. Hindari postur tubuh membungkuk pada saat melakukan aktivitas pengangkatan. Rendahkan dahulu posisi punggung baru kemudian ambil barang yang akan diangkat seperti pada gambar di bawah ini.



2. Dekatkan barang yang diangkat ke badan pada saat aktivitas pengangkatan



3. Lakukan pengangkatan berkelompok jika barang terlalu besar atau tidak memungkinkan dibawa sendiri.



4. Jika mengangkat barang yang berada pada posisi lebih tinggi gunakanlah tangga.



5. Jika barang diangkat pada bagian bahu, tempatkan bantalan pada bagian bahu untuk mencegah cedera yang timbul.



6. Istirahat cukup sesuai dengan kebutuhan fisik pekerja.
7. Prosedur lain dapat dilihat pada dokumen *Ergonomic Guidelines for Manual Material Handling* yang dikeluarkan oleh *California Department of Industrial Relations*.

