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APPLICATION OF RECOMMENDED WEIGHT LIMIT (RWL) AND LIFTING INDEX (LI) TO ANALYZE PHYSICAL AND MENTAL LOAD

(Case Studies: PT. KIMIA FARMA (PERSERO) PLANT BANDUNG)

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Abstract

In a company, every single worker has different both duties and responsibilities, and each activity carried out will produce workload apart. The lifting, moving and lowering by manually is a lot of done by workers (man power). This research aims to determine the workload, both physically and mentally in the manual material handling activity at PT. Kimia Farma Plant Bandung which considers health and safety factors for operators. For propose to discover workload which exists in the material handling manual activity by measurements using the Recommended Weight Limit (RWL) and Lifting Index (LI) method. Based on results obtained, the starting method of LI was 9.17. This indicates that lifting boxes activity by raw material warehouse officers poses a high risk of injury. For decreasing risk, the way lifting method have to change. As for the suggestion of tighten loads, don't over bending and reduced from 4 to 3 boxes only for stacking position. For suggestion method of Lifting Index was 3,59. The suggestion lifting method is better when we compared it with the old one. Seen from the decrease in the Lifting Index value of the old method when compared with the suggestion.

Keywords: *Method, Workload & mentality, Recommended Weight Limit (RWL), Lifting Index (LI), Labor*

1. Introduction

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Humans are the main factor in the success of a company, besides that humans have limitations in doing every job, therefore it does not rule out the possibility that workers will experience fatigue (Nurmianto. 2003).as a consequence work mistakes that affect the company's losses. Either errors occurs due to workload that is exceeds the ability of the worker. For successfully of a job can be influenced by many factor for example the physical work factor (workload). Physical work (workload) result in energy expenditure thus affecting ability of man power work performance.

PT. Kimia Farma (persero). TBK is a manufacturing company activated in the pharmaceutical and health care sectors that helped developing Indonesian public health. For production activities are still lot of use human labor (man power), such as the process of moving raw materials and finished products to the storage process, by being pushed, pulled, lifted, lowered, dragged and thrown. These activities are carried out by workers repeatedly, using of strong human power with excessive force, an insufficient work position, excessive hand tremors due to the loads being lifted, and physical contact with sharp surfaces objects, lack of assistive devices, Personal Protective Equipment (PPE) that has not standard qualified, added with uncomfortable working environment including lack of lighting, placement of objects or work tools that are not in place, mismatched trajectory and layout that has not functioned in accordance with the provisions so that the production process flow less than optimal.

Under these circumstances it will emerge the complaints experienced by workers, among others, the onset of pain in the muscles involved, genial or physical fatigue quickly, boredom and a sense of stress. If the condition lasts every single day and for a long time it will result in permanent ailment and faithless, spinal cord injury, muscle injuries, joint injuries and mental disorders. (Wignjosoebroto, 2000).

2. Study Literature

A. Ergonomi

Accodring Sutalaksana (1970), Ergonomics is the science discipline that learn to build a whole work system throughout the information of human character including human behaviour, human weakness and human abilities. It all needed to design a fitting work system to the worker for effective and efficient reaching the main goal.One of the steps that can be taken to improve the work system is the Nordic Body Map Questionnaire. The tools is use to find out discomfort / pain complaints on the body of the worker. Nordic Body Map is one of the most frequently used reasons because it is standardized and neatly arranged. by using this method approach, it can be seen the parts of the muscles that are experiencing complaints with the level of complaints ranging from discomfort (about pain) to very sick (Sukania, et al., 2012).

Biomechanics is defined as the field of application of mechanics in biological systems. Biomechanics is a combination of applied mechanical and biological and physiological sciences. In practice biomechanics studies the strength, endurance and accuracy of humans in doing their work (Soleman, 2011). National Institute for Occupational and Health (NIOSH) which was established in 1981 has been able to create equations that can help practitioners evaluate the work of lifting objects manually, by paying attention to the safety and health aspects of workers. The equation issued by NIOSH gives the theoretical lift load value suggested for the work of lifting the object called RWL (Recommended Weight Limit)

B. Recommended Weight Limit (RWL)

RWL (The Recommended Weight Limit) is a safe limit in lifting the burden carried out by a worker without causing injury even though the activity is carried out repeatedly in a very long period. in 1991 NIOSH recommended the Recommended Weight Limit (RWL) as a burden that was safely lifted by humans (Waters, et al, 1994).

a. A load given is static, there is no addition or subtraction on the sidelines of the work.
b. Weights are lifted using both hands.
c. Maximum lifting or lowering of objects within 8 working hours
d. Lifting or unloading objects should not be done while sitting position.
e. The workplace is not narrow / limited.

According to NIOSH Equations in provide a recommended load limit for workers in lifting workloads, determining the recommended load for lifting workloads, with the condition of the worker a work in a others conditions (Waters, et al, 1993).
RWL = LC x HM x VM x DM x AM x FM x CM

Definition:

RWL : Recommended Weight Limit

LC : Load Constant

HM : Horizontal Multiplier = 25 /H

VM : Vertical Multiplier = 1- (0,003 |V-75|)

DM : Distance Multiplier = 0,82+4,5/D

AM : Asymmetric Multiplier = 1-0,0032 A

FM : Frequency Multiplier

CM : Coupling Multiplier (*handle*)

The following is the explanation of the variables included in the load limit calculation formula recommended by NIOSH:

a. *Load Constant* (LC)
According to NIOSH the maximum recommended constant load for lifting at a standard location is 23 kg
b. *Horizontal Multiplier* (HM)
This aspect of the horizontal multiplier is influenced by the distance of the hand to the middle point of the distance of an object
c. *Vertical Multiplier* (VM)
This aspect of vertical multiplier is a determined by the apsidal distance of the soil to the midpoint of the grip of both hands. This is lifting by biomechanics can be seen in Figure 1.

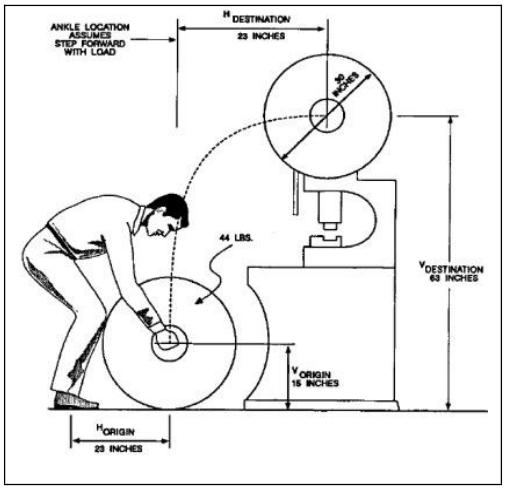

Figure1. Distance of Horizontal and Vertical

d. *Distance Multiplier* (DM)

Aspects of the distance multiplier based on the location of the vertical position is a different from the original vertical position with the final position of the different destinations can be seen in Figure 2.

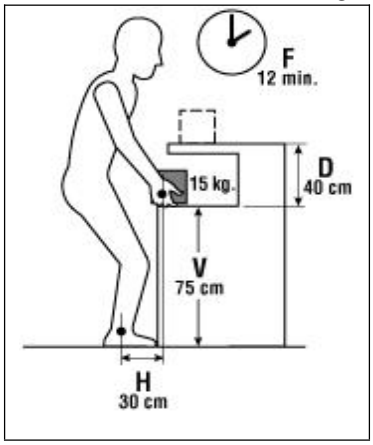

Figure2. Distance of Horizontal, Vertical, and Travel (Moving)

e. *Asymetric Multiplier* (AM)

Angular measure (Variable A) is a multiplier factor that is influenced by how far the object can be moved from front to side, and is also influenced by the movement of workers Asymmetric angle representation recan be seen in Figure 3.

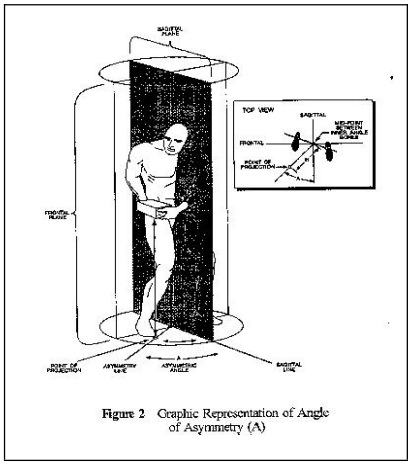

Figure3. Asymmetric angle representation

f. *Frequency Multiplier* (FM)

Frequency multipliers are influenced by the value of the amount of lifting the load in a certain time period, with the lifting distance of the vertical lifting distance from the floor.Multiplier representation can be seen in Table 1

Tabel 1. *Multiplier frequency*

frequency lifts / min	**Work Duration**					
	= 1hour		**> 1 but = 2 hours**		**> 2 but = 8 hours**	
	V<30	V=30	V< 30	V=30	V<30	V=30
= 2.0	1.00	1.00	0.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.75	0.75
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.80	0.80	0.60	0.60	0.35	0.35
6	0.75	0.75	0.50	0.50	0.37	0.27
7	0.70	0.70	0.42	0.42	0.22	0.22
8	0.60	0.60	0.35	0.35	0.18	0.18
9	0.52	0.52	0.30	0.30	0	0.15
10	0.45	0.45	0.26	0.26	0	0.13
11	0.41	0.41	0	0.23	0	0
12	0.37	0.37	0	0.21	0	0
13	0	0.34	0	0	0	0
14	0	0.31	0	0	0	0
15	0	0.28	0	0	0	0
>15	0	0	0	0	0	0

g. *Coupling Multiplier* (CM)
Coupling Multiplier is one a multipliers which is influenced by the way the worker holds the object being hold. can be seen in Table 2

Table 2. Coupling Multiplier.

Tipe Coupling	**Coupling Multilier**	
	V < 75 cm	V > 75 cm
Good	1	1
Fair	0.95	1
Poor	0.9	0,9

C. Lifting Index (LI)

LI is a terminology that provides an evaluation of the phase of physical strength involved in lifting certain weights, which define among them is as follows:
LI = Load Weight / min (RWL Start Process; RWL Ending Process)
By following terms:

a. If the value of LI > 1 (*moderately stressful task*), the weight lifted exceeds the recommended lifting limit then the activity carries a the risk of physical spinal defects.

b. If the value of LI < 1, the weight lifted does not exceed the recommended lifting limit then the activity does not contain the risk of physical spinal defects.

c. If value of LI >3 (*highly stressful task*), can be ascertained overexertion.

3. Research Method

The procedures carried out in this research are as follows:

A. Preliminary Research Phase, includes :
   1) Formulation of the problem to be examined,
   2) Literature and Object Review,
   3) Formulation of Research Objectives.

B. Identification Phase, includes :
   1) Selection of the method to be used,
   2) Determination of research sites,
   3) Determination of data needed.

C. Data Collection Phase, includes :
   1) Giving Nordic Body Map (NBM) questionnaires to raw material warehouse officers.
   2) Photograph of officers / officers movements
   3) Measurement of Variables H, V, D, A, F, and C

D. Data Processing and Analysis Stage, including :
   1) Implement multiplier calculation for RWL determination
   2) Implement lifting index calculations,
   3) Analyzing the results of processing.

E. Closing.

4. Result and Discussion

The process of collecting data by taking photos at the time of the Recommended Weight Limit (RWL) measurement process. The following figure 4 and 5 below when measuring the Recommended Weight Limit (RWL) measurement can be seen:

Figure 4. Starting Position
(Source: Data Collected)

Figure 5. Final Position
(Source: Data Collected)

According on the results of real condition objective data in this process, the raw material officer moves the box from trolley to pallet. Each box contains the ingredients of Ascorbic Acid weighs 20 kg. A single pallet consists of 64 boxes with a stacking position, 4 x 4 with 4 stacks, but first thing will be analyzed is the Weight of 20 kg load, because if the weight of this has exceeded the recommended of course the heavier load (next) will also certainly eclipse. Lifting the box as shown in Figure 1 with a bent posture for starting position then standing and hands supporting the bottom of the box. In the final position of the box stacked on a pallet to be arranged. Work posture as in figure 1 could be increase a risk of spine injury.

Next for collecting data process are the physical characteristics of worker and variable data H (Load distance to center of body), V (Load distance to floor), A(Symmetry angle of the worker's body rotation), D (distance of the vertical load transfer).Table 3 and the following obtained data:

Table 3. Position 1 Measurement

Position 1		
RWL	**Start**	**Final**
LC	23	23
H	35	67
V	75	142
D	67	67
A	0	0
F	11	11
C	Poor	Poor

(Source: Data Collected)

A. Calculated of RWL and LI

Table 4. Results of RWL multiplier calculation

LC	HM		VM		DM		AM	FM	CM
23	Start	Final	Start	Final	Start	Final	1	0,41	0,90
	0,71	0,37	1	0,78	0,89	0,89			

Calculated of Recommended Weight Limits:

RWL Start = LC × H.× V ×.D × A × F × CM
= 23 × 0.71 × 1 × 0.89 × 1 × 0.41 × 0.90
= 6.06 kg

RWL Final = LC × H × V × D × A × F × CM
= 23 × 0.37 × 0.78 × 0.89 × 1 × 0.41 × 0.90
= 2.18 kg

Calculated of Lifting Index:

$$\text{Lifting Index} = \frac{Force\ Load}{\min (\text{RWL Start:RWL Final})}$$

$$\text{Lifting Index} = \frac{BForce\ Load}{\min (6.06\ ;2.18)}$$

$$= \frac{20}{2.18}$$

$$= 9.17$$

From the calculation above it appears that LI value is more than 3. It means high risk injury faced by workers. This is caused by a minor horizontal multiplier value (0.71), a minor vertical multiplier value (1) and a minor frequency multiplier value (0.89).

B. Description of Lifting works (Suggestion Method)

For getting minor Lifting index value, we have to increase the multiplier value of the horizontal factor, as well as the vertical multiplier value and the frequency multiplier value . In addition, during of the lifting, the worker should not over bending and the items should be placed close to the body. This process to reduce the horizontal distance in purpose the value of the horizontal multiplier increases, and the stack of goods is reduced from 4 to 3 boxes in purpose the distance from start to final lift is not too high.

For the new method, the worker has to get closer to the object being lifted. The purpose is lifting process not over bending as shown in Figures 6 and 7.

Figure 6. Starting Position
(Source: Data Collected)

Figure 7. Final Position
(Source: Data Collected)

Table 5. Position 2 Measurement

Position 2		
RWL	**Start**	**Final**
LC	23	23
H	28	33
V	55	94
D	39	39
A	0	0
F	11	11
C	Poor	Poor

(Source: Data Collected)

C. Calculated of RWL and LI

Table 6. Results of RWL multiplier calculation

LC	HM		VM		DM		AM	FM	CM
23	Start	Result	Start	Result	Start	Result	1	0,41	0,90
	0,89	0,76	1,65	0,94	0,92	0,92			

Calculated of Recommended Weight Limit:

RWL Start $= LC \times H \times V \times D \times A \times F \times CM$
$= 23 \times 0,89 \times 1,65 \times 0,92 \times 1 \times 0,41 \times 0,90$
$= 11.47$ kg

RWL Final $= LC \times H \times V \times D \times A \times F \times CM$
$= 23 \times 0,76 \times 0,94 \times 0,92 \times 1 \times 0,41 \times 0,90$
$= 5,57$kg

Calculation of *Lifting Index* (**LI**)

$$\text{Lifting Index} = \frac{\text{Force Load}}{\min(\text{RWL Start:RWL Final})}$$

$$\text{Lifting Index} = \frac{Force\ Load}{\min(6.06\ ;2.18)}$$

$$= \frac{20}{5,57}$$

$$= 3,59$$

From the calculation above it appears that Final Lifting Index value is 3,59. Furthermore, there is a decrease in the value of start Lifting Index and proposed Lifting Index. It means level of worker's injury risk is also decreasing.
After implementation, interviews were conducted again to find out the subjective complaints by workers. The result of the interview is a decrease in subjective complaints in the back, waist, right upper arm, left upper arm. There is an increase in subjective complaints of workers in foot area because their legs bend at the time of lifting.

5. Conclusion

Based on the results of analysis, observation and data.processing, it can be concluded:

a. Based on the output of interviews and using the Nordic Body Map questionnaire to workers that complaints that often occur are the back, left upper arm, right upper arm, wrist, and waist area.

b. Based on the output of RWL and LI calculations indicated that lifting of box by the raw material warehouse officer raises the risk of physical due for a value of LI> 3. It will be dangerous for workers if keep on track for long term period.

c. The suggestion lifting method is better when we compared it with the old one. Seen from the decrease in the Lifting Index value of the old method when compared with the suggestion.

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