Risk Analysis of Musculoskeletal Disorders Using RWL And LI Methods

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ABSTRACT

At PT. X, there is a manual material handling activity with a total load of 23 kg, namely taking water treatment analysis samples. Workers often complain of pain in their arms and backs as a result of these activities, and the load carried is considered quite heavy. This is the background of this research. Therefore, the purpose of this study is to determine the recommended load weight and the risk of spinal injury in these activities so that workers can work more effectively and efficiently. In completing this study, the methods used were the Recommended Weight Limit (RWL) and Lifting Index (Li) methods. These methods were used because they were assessed in accordance with the research objectives. From the results of this study, it is known that the recommended load weight is 8 kg and the Li > value is 1, which means that the activity has a risk of spinal injury.

Keywords: *ergonomic, recommended weight limit, lifting index, musculoskeletal disorders, manual material handling, work posture*

Introduction

PT X is the most comprehensive manufacturer of fertilizers in Indonesia, producing a variety of chemicals and fertilizers for agro-industrial solutions. In order to keep the quality of the product so that it remains good and continues to produce, quality control is needed, which is carried out in the laboratory unit. In the work unit or section where the research is carried out, it is in Laboratory 1B, which has the task of controlling the quality of the production process and the quality of urea products. The work system applied is the shifting work system. At the beginning of each shift, the workers do sampling or testing to analyze the quality of their products. There are 3 categories of samples for analysis, including ammonia, water treatment, and urea. Each category has a different number of samples, and the topic of this study is water treatment.

In water treatment, there are a total of 23 sample points analyzed, with each sample point containing as much as 1 liter per sample point, or, if converted into weight units, 1 kilogram per sample point. This means that the total weight of the sample is 23 kg, which must be handled manually by workers. The burden is certainly quite heavy if lifted by a worker. Moreover, coupled with the distance raised is quite far from the place of analysis.

In the activity of taking analytical samples for water treatment with a total weight of 23 kg, it was done manually without using tools. Workers carry the analysis samples in jerry cans measuring 1 liter per analysis sample, then the jerry cans are arranged in a basket to make them easier to carry. However, the weight of the analysis sample is quite heavy, so workers often complain when taking the analysis sample. Pain in the upper arm and shoulder is a complaint that is often disturbed by workers. This is the background to this study.

The main problem to be formulated in this study, based on the background of the problem above, is to recommend a pattern of activity in taking analytical samples by considering the lifting work posture by counting, among other things. What is the value of RWL and LI that the worker should raise, whether the worker is at risk or not? Based on the burdens lifted thus far, how to propose improvements to the effect of the spine on workers. In this study, the goal is to determine the value of recommended weight limit (RWL) and lifting index (LI), provide suggestions, and find out whether the activities carried out by workers at the time of taking analysis samples pose a risk or are still within a safe limit.

Manual Material Handling

Manual Material handling, by definition, refers to workers who use their hands to lift and handle materials. Material handling manuals include handling, moving, packaging, storing, and controlling materials in all their forms [1].

So far, the concept of manual material handling (MMH) is only limited to lifting and lowering activities in terms of vertical strength. even though there are still other activities in MMH, such as pushing and pulling. The manual material handling activities that are commonly carried out in an industry or company include the following:
1. Carrying Tasks
2. Pushing Task
3. Lifting Task
4. Pulling Activities (Pulling Task) in Banda

It makes sense to use human resources as manpower when performing material handling tasks. Manual material handling has a number of benefits, including:
1. At a light load, It will be less expensive than using a machine.
2. More flexible movement makes it easier to move objects in tight spaces and during irregular work.
3. Not all materials can be moved with tools or machines.

Manual weight transfer, if not done ergonomically, can cause work accidents, namely the loss of body tissues due to excessive load lifting.

Musculoskeletal Disorders

Musculoskeletal Disorders (MSDs) are disorders or conditions that cause people to experience mild to severe pain in the musculoskeletal joints, which include the joints, nerves, muscles, and spine, as a result of unnatural work. Due to disturbances in this part, performance when carrying out daily activities will be disrupted, reducing productivity [2].

Conditions known as musculoskeletal disorders affect the spine as well as joints, ligaments, muscles, nerves, and tendons. The musculoskeletal system includes supporting components for the neck, back, and limbs. Musculoskeletal diseases (MSDs) or injuries to the musculoskeletal system are typical names for these problems. MSDs can result in losses for workers and even the building shop itself with manual material handling activities that are unsuitable so that they can create interruption, thus there is a requirement for Brick lifting in this building shop was manually analyzed utilizing the suggested weight limit technique. Calculate the lifting index to determine the divergence of the load lifted from the recommended load limit after you are aware of the recommended weight limit's value.

Recommended Weight Limit

The Recommended Weight Limit (RWL) is the suggested weight that people should be able to lift without getting injured, even if they do it repeatedly and for a very long time. This RWL was introduced by NIOSH in 1991 in the United States. The NIOSH equation applies to the state of
1. The load is static, meaning it doesn't increase or decrease while the procedure goes on.
2. The burden is raised using both hands.
3. The removal or lowering of objects is completed in no more than 8 hours.
4. Objects should not be raised or lowered when seated or kneeling.
5. There is enough space for work.

The author measured the influencing elements in load lifting with reference to NIOSH provisions based on the load lifting attitudes and conditions work system in the process of loading items performed by workers in trials. According to NIOSH, the following formula can be used to determine the recommended weight for a worker to lift under specific circumstances :

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM$$

Note :
- LC : (Lifting Constnta) loading constant
- HM : (Horizontal Multipler) from the factor of horizontal multiplier
- VM : (Vertical Multiplier) from the factor of vertical multiplier
- DM : (Distance Multiplier) from the factor of displacement multiplier
- AM : (Asymentric Multiplier) from the factor of asymmetric multiplier
- FM : (Frequency Multiplier) from the factor of frequency multiplier
- CM : (Coupling Multiplier) from the factor of coupling multiplier (handle)

Note:
- H = The separation between the hand holding the load and the body's center in a horizontal direction.
- V = The distance vertically between the hand while carrying the load and the ground
- D = The transfer of vertical load distance among the source to the destinations
- A = The angle of symmetrical created by the feet and hands.

For Freqeuncy Multiplier (FM) is:
1. Short duration   = ≤1 hour
2. Medium duration = 1≤ X ≤2 hours.
3. Long duration   = 2 ≤ X ≤8 hours.

For Coupling Multiplier (CM) are:
1. Good criteria, include:
   a. The best design is a container or box, as the material's handle is not slick.
   b. The objects inside are not easy to spill.
   c. The box is easily graspable in the hands.
2. Fair Criteria, include:
   a. Boxes or containers without handles.
   b. The hands are difficult to extend.
3. Poor's standards, are:
   a. The box is without a handle.
   b. Complicated to hold (Slippery, Sharp, etc).
   c. Has unstable objects, (Rupture, Fall, Spill, etc.).
   d. Must be lifted with gloves on.

Lifting Index

The process of the recommended weight limit approach results in the Lifiting Index calculation to determine the indications of removal without the potential of bone injury, the equation is:

$$LI = (Load\ Weight/RWL)$$

If LI > 1, the risk of spinal injury is increased because the weight of the object being lifted is greater than the recommended weight limit. If, according to LI < 1, the load that was lifted is within the safe lifting range, and there is no chance of spinal injury during the activity.

Research Methods

This research is a descriptive study. Researchers take data from interviews and observations directly at the research site. Interviews were conducted on all workers who took water treatment analysis samples every day, with a total of 8 respondents. The methods used in this study are the Recommended Weight Limit (RWL) and Lifting Index (LI) methods.

To facilitate this research process, first create a research scheme to map the steps in completing this research. The following research scheme can be seen in figure 1 :
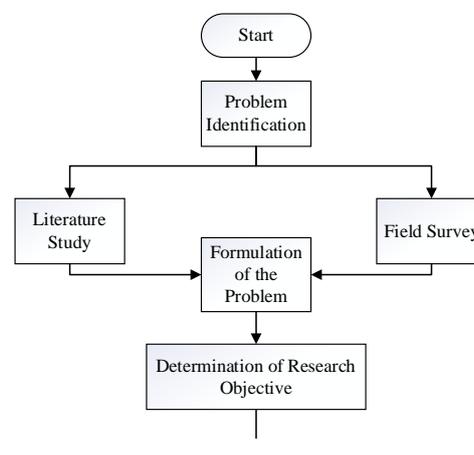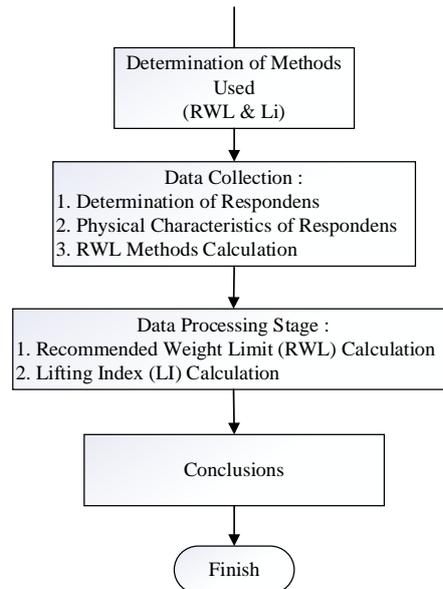
Figure 1 Research Flowchart

1. Start
2. Problem Identification
   Problem identification is carried out to find out the problems that are happening at the research site and which are the background in this research.
3. Literature Studies
   Collection of literature studies as reference material. Literature study information is taken from books and research journals whose purpose is to help complete research reports.
4. Field survey
   Field survey or initial survey, because this stage is very necessary to find out the real conditions to be studied. This is to avoid any incompatibility between the research objectives and the actual conditions.
5. Problem Formulation
   Formulation of problems with the aim of limiting the focus of the topic to be discussed, namely to find out the recommended weight of the load and know the risk of injury to the spine.
6. Determination of Research Objectives
   Determining the research objectives that are the main focus in completing this research based on the formulation of the problem that has been made.
7. Determination of the method used
   In this study, the methods used were the Recommended Weight Limit (RWL) and Lifting Index (Li) methods. The method was chosen because it was judged to be appropriate or relevant to the purpose of this study.
8. Data Collection
   Data collection that is a supporting material in the completion of this research, including :
   a. Determination of respondents
      The respondents in this study were all workers in the pt. x laboratory who took samples for water treatment process analysis, with a total of 8 respondents.
   b. Physical characteristics of respondents
      Physical characteristics of respondents (workers) include weight, height, and age.
   c. Observation data of sample transfer analysis conducted by respondents
      The data obtained when respondents transferred the analysis sample, the data was used in calculations using the Recommended Weight Limit (RWL) and Lifting Index (Li) methods
9. Data Processing
   After the data is collected, the data is then used for calculations using the Recommended Weight Limit (RWL) and Lifting Index (Li). The formula for calculation using this method is as follows:
   a. Recommended Weight Limit (RWL)

   $$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM$$

   b. Lifting Index (Li)

   $$LI = (Load\ Weight/RWL)$$

10. Conclusion
    After the data processing process is complete, conclusions can be drawn from the results of this research.
11. Finish

Results and Discussion

The picture 2 below is the body position of one of the respondents (workers) when carrying the water treatment analysis sample with the total weight of the analysis sample is 23 Kg.

Figure 2. The workers' body position while carrying the 23 kg water treatment analysis sample

From figure 2, you can see the value of H (horizontal distance) marked with the letter D, the value of V (vertical distance) marked with the letter A, and the value of A (asymmetric angle) marked with the letter C. Then for the overall data of all respondents can be seen in Table 1 and Table 2.

Table 1. Physical characteristic of workers

Name	Age	Height (cm)	Weight (kg)
Respondent 1	22	165	50
Respondent 2	23	160	80
Respondent 3	22	180	90
Respondent 4	24	169	63
Respondent 5	24	176	84
Respondent 6	21	170	70
Respondent 7	22	167	82
Respondent 8	22	178	89

Table 1 is a data on the physical characteristics of all respondents, which includes the weight and height of the respondents.

Table 2. Data on the observation of the process of lifting sample analysis carried out by workers

Name	H	V	D	A	Fm	Cm
Respondent 1	40	83	100	90	1	1
Respondent 2	37	80	100	90	1	1
Respondent 3	47	90	100	90	1	1
Respondent 4	41	85	100	90	1	1
Respondent 5	44	88	100	90	1	1
Respondent 6	42	85	100	90	1	1
Respondent 7	42	84	100	90	1	1
Respondent 8	44	89	100	90	1	1

In table 2, all observation data from respondents (workers) can be seen when taking samples. After the data is collected, calculations are then carried out using the recommended weight limit (RWL) and lifting index (Li) methods. The calculation can be seen in table 3 :

Table 3. The result data of the Recommended Weight Limit (RWL)

Name	HM	VM	AM	DM	CM	LC	RWL
Resp 1	0.63	0.99	0.71	0.87	1	23	8.765
Resp 2	0.68	0.99	0.71	0.87	1	23	9.475
Resp 3	0.53	0.96	0.71	0.87	1	23	7.233
Resp 4	0.61	0.99	0.71	0.87	1	23	8.551
Resp 5	0.57	0.96	0.71	0.87	1	23	7.726
Resp 6	0.60	0.99	0.71	0.87	1	23	8347
Resp 7	0.60	0.99	0.71	0.87	1	23	8.347
Resp 8	0.57	0.96	0.71	0.87	1	23	7.726

From the calculations in Table 3, it can be seen the recommended load weight for each respondent (worker), with the average recommended weight being 8 kg. Furthermore, calculations are carried out using the Lifting Index (Li) method to determine the risk of spinal injury. The calculation can be seen in table 4 :

Table 4. Result of Lifting Index (Li)

Name	RWL	Li
Respondent 1	8.76474	1.93959
Respondent 2	9.4754	1.79412
Respondent 3	7.23331	2.35024
Respondent 4	8.55097	1.98808
Respondent 5	7.72649	2.20022
Respondent 6	8.34737	2.03657
Respondent 7	8.34737	2.03657
Respondent 8	7.72649	2.20022

Based on table 4, it can be seen that the lifting index value of each respondent (worker) is more than one. This value is used to determine the risk of a spinal cord injury. In accordance with the provisions, if the value of Li is greater than 1, then the activity has a risk of causing injury to the spine. So it is necessary to make improvements using manual tools or layout improvements to make it more effective and efficient.

Conclusion

Based on the results of analysis and observation, as well as the data processing that has been carried out using the RWL and Li methods, it can be concluded as follows:
1. The weight of the load carried by the respondent is currently 16-23 kg , the weight does not match the recommended weight obtained from calculations using the RWL method, namely with an average average weight of 8 kg for each respondent (worker). The recommendation weight for each respondent can be seen in table 5:

Table 5. Recommended Weight Limit Results

Name	RWL
Respondent 1	8,76474
Respondent 2	9,4754
Respondent 3	7,23331
Respondent 4	8,55097
Respondent 5	7,72649
Respondent 6	8,34737
Respondent 7	8,34737
Respondent 8	7,72649

2. In accordance with the outcomes of calculations made using the RWL approach. Consequently, each response's LI value is as follows:

Table 6. Lifting index result

Name	Li
Resp 1	1,93959
Resp 2	1,79412
Resp 3	2,35024
Resp 4	1,98808
Resp 5	2,20022
Resp 6	2,03657
Resp 7	2,03657
Resp 8	2,20022

The value is more than 1, in accordance with the provisions if LI > 1, indicates that if the object's weight being lifted is greater than the recommended weight limit, a spine injury may result from the exercise.

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