Analysis of the Use of Ergonomic Trolley on Musculoskeletal Complaints on Worker Transporting Gallons of Water and LPG 12Kg

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Keywords: Trolley, Musculoskeletal, Fatigue.

Abstract: Everyday, the use of water and gas is very important for human life, especially drinking water and LPG gas. As time goes by, the need for drinking water and LPG gas is increasing every day, because people are aware of their health and desire to live a more practical life. With the increasing demand for drinking water and LPG gas, many drinking water and LPG gas companies are packaged with large capacities. such as gallon water with a capacity of 19 liters and LPG gas measuring 12 kg. If the weight of gallon water reaches 19kg and 12kg LPG gas reaches 27kg, this can cause workers to be tired and overwhelmed to serve consumers. Moreover, consumers live on the 2nd floor apartment which must still be served. Lifting workers in general, lift gallons of water and 12kg LPG gas using their hands and carry them and the work is done repeatedly, this can cause muscle injuries, especially in the wrists, elbows and shoulders. In addition, the time used is relatively long due to the limitations of workers who can only carry 1 gallon or 1 piece of 12 kg LPG gas, especially customers with long haul-haul distances, which require workers to carry them without any tools. As a solution to these problems, an ergonomically designed trolley was made so that the lifting and transport workers could work in a healthy, safe and comfortable manner. In this study, a 12kg LPG gas carrier and 2 gallons of water will be designed and continued by analyzing the use of these tools for workers in terms of musculoskeletal muscle complaints and fatigue levels. Specifications This trolley has been ergonomically designed that has been adapted to the anthropometry of the worker's body and is capable of transporting 2 gallons of aqua or 2 12 kg LPG gas. The trolley design results with dimensions: 70 cm wide and 140 cm high with a weight of 60 kg, quite simple to move around The results of testing and analysis of musculoskeletal complaints and fatigue levels were obtained that: The average musculoskeletal complaints of workers before working using a trolley was 44.02 (±2.56) and the average musculoskeletal complaint after working using a trolley was 33.04 (±4.17) which means there is a decrease in musculoskeletal complaints by 24.9%. The average level of fatigue of workers before working using a trolley is 44.11 (±2.17) and the average level of fatigue after working using a trolley is 33.03 (±3.22) which means there is a decrease in the level of fatigue by 25.1%.

1 INTRODUCTION

Everyday life, the use of water and gas is very important for human life, especially drinking water and LPG gas. As time goes by, the need for drinking water and LPG gas is increasing every day, because people are aware of their health and desire to live more practically. With the increasing demand for drinking water and LPG gas, many drinking water and LPG gas companies are packaged with large capacities such as gallon water with a capacity of 19 liters and LPG gas measuring 12 kg. If the weight of gallon water reaches 19kg and 12kg LPG gas reaches 27kg, this can cause workers to be tired and overwhelmed to serve consumers.

Lifting workers in general, lift gallons of water and 12kg LPG gas using their hands and carry them and the work is done repeatedly, this can cause muscle injuries, especially in the wrists, elbows and shoulders. In addition, the time used is relatively long due to the limitations of workers who can only carry 1 gallon or 1 piece of 12 kg LPG gas, especially

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Santosa, I. and Muliati, N.
Analysis of the Use of Ergonomic Trolley on Musculoskeletal Complaints on Worker Transporting Gallons of Water and LPG 12Kg.
DOI: 10.5220/0010939800003260
In *Proceedings of the 4th International Conference on Applied Science and Technology on Engineering Science (iCAST-ES 2021)*, pages 55-59
ISBN: 978-989-758-615-6; ISSN: 2975-8246

customers with long haul-haul distances, which require workers to carry them without any tools.

As a solution to this problem, an ergonomically designed trolley was made so that the lifting and transport workers could work in a healthy, safe and comfortable manner. In this study, a 12kg LPG gas carrier and 2 gallons of water will be designed and continued by analyzing the use of these tools for workers in terms of musculoskeletal muscle complaints and fatigue levels. Lifting workers in general, lift gallons of water and 12kg LPG gas using their hands and carry them and the work is done repeatedly, this can cause muscle injuries, especially in the wrists, elbows and shoulders. In addition, the time used is relatively long due to the limitations of workers who can only carry 1 gallon or 1 piece of 12 kg LPG gas, especially customers with long haul-haul distances, which require workers to carry them without any tools.

The main problems of the work process using muscles and working time are long enough to cause an increase in musculoskeletal complaints and fatigue and an increase in workload which in turn reduces work productivity, increases fuel costs and longer working time. Adiputra (2000) said that through ergonomic intervention in small-scale industries using ergonomic work equipment will reduce workload and subjective complaints significantly thereby increasing productivity. Several alternative solutions to the problems above through an ergonomic approach are: designing ergonomic work tools is expected to reduce musculoskeletal complaints and fatigue levels, so as to increase worker productivity (Manuaba, 2000; Khroemer and Grandjean, 2009).

2 METHOD

2.1 Research Design

This research is a one-short case study with a pre and post-test design group which was conducted observationally on the working process of lifting gallons [5]. Chart can be described as follows:

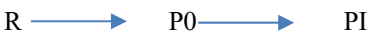


Figure 1: Research Design.

Information:
R = Random sample.
P0= the result of the pre-test experimental unit.
PI = the result of the post-test experimental unit.

2.2 Research Variable

The variables to be measured in this study include: (1) musculoskeletal disorders before and after work by filling nordic body map questionnaire; (2) work fatigue before and after work by filling out the 30 fatigues rating questionnaire. The initial condition information data and the final condition were then compared to find out the comparison before using the trolley by manual lifting.

2.3 Data Analysis

The trolley design data is calculated based on the routine work activities of workers when lifting gallons of water or LPG gas to. Test data before the use of the trolley and after the use of the trolley includes data on musculoskeletal complaints and data on worker fatigue and working time which will then be analyzed descriptively to obtain conclusions.

3 RESULT AND OUTCOME

3.1 Lifting Gallons and LPG Gas Manually

Based on the results of interviews with workers lifting and transporting Aqua gallons and 12 Kg LPG gas, they work for 8 hours, from 08.00 WITA to 17.00 WITA with 1 hour rest time. With an average lifting distance of up to 800 meters to lift an average of 150 gallons, either to stalls/shops or to consumers' homes and there are also some consumers who live on the 2nd floor, so they have to climb up to 46 stairs for a 4-storey house. 2 by carrying 8 gallons. From this work, the labor market often complains of pain in the wrist and waist

To overcome this problem, workers are advised to use a trolley as a work aid. The use of this trolley is quite easy, safe and comfortable. By positioning the trolley standing and workers can put 2 gallons of water or LPG gas. Furthermore, the gallon of water or LPG gas is tied up for safety, after that it is laid down to be pulled with light power to the consumer.

Figure 1: Body position lifting gallons.

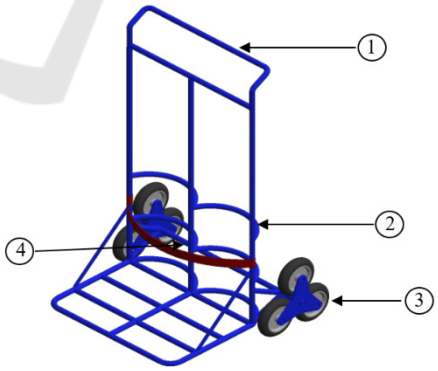
Figure 2: Body position lifting LPG 12 kg.

If the muscles receive static loads repeatedly over a long period of time, it can cause complaints in the form of damage to joints, ligaments, and tendons. These complaints are usually referred to as musculoskeletal disorders (MSDs) or injuries to the musculoskeletal system (Kroemer and Grandjean, 2009). Based on recommendations from the Occupational Safety and Health Administration (OSHA), ergonomic measures to prevent disease sources are in two ways, namely engineering engineering through the design of work stations and tools and management engineering through work criteria and organization (Corlet, 2005; Rusdiyantoro, 2011).

3.2 Trolley Design Model

An effort to create a safe and comfortable working condition, it is necessary to have good interaction from the three components mentioned above, namely humans, machines, and the work environment. In ergonomics, humans are the most important component that must be considered with all the limitations it has. In other words, the demands of work tasks should not be too low (underload) and should not be too excessive (overload) because both will cause stress (Suma'mur, 2003). A good design can be produced by recognizing the characteristics, limitations, and abilities of humans. Humans play a central role in their activities, namely as planners, designers, implementers, and evaluators in every activity (work). Humans as a source of labor are still dominant in carrying out the production process, especially activities that are repetitive. Ergonomically designed equipment needs to be carried out based on ergonomic principles (Santosa, IG., Susana, IGB., 2021; Yusuf, M., 2014;).

Stone tools such as trolleys should be designed to be easy and practical to use. Basically, in making this tool, it aims to simplify the work process of the workers. The product of this trolley design is expected to improve the health and work effectiveness of the workers themselves.



1. Iron Pipe
2. Iron Strip
3. Trolley Tires
4. Axle

Figure 3: Trolley Design.

3.3 The Result of Ergonomics Test using Trolley

a. Musculoskeletal Complaint

Every human being works, regardless of the type of work done, the muscles of the body will definitely contract and relax alternately (Rolles, et.al., 2009). This occurs as a result of the activity of the limbs in maintaining a stable body position, or certain movements in carrying out tasks. The more movements that are contrary to physiological rules are carried out, the more energy is used (Torik, at.al., 2009). The more the attitude of the body against the neutral stance of the body the more the muscles work. Likewise, if the body is increasingly fixed in a working position in a certain work position, the longer certain muscle groups will contract. Moreover, if it is done repeatedly, it will result in muscle fatigue (Tarwaka, 2010). This form of muscle fatigue is accompanied by a sensation of pain or in the muscles. All of which can be detected in the form of complaints in the muscles. Which type of muscle is affected depends on the severity of the task, and the monotony of the movement.

Data on musculoskeletal complaints were obtained subjectively from filling out the Nordic body map questionnaire using a 4 Likert scale. The craftsman will cross the available numbers from 0 - 27 according to the complaints they feel. Before testing the effect of using a trolley, the data obtained were tested with a normality test. Based on the normality test with Shapiro Wilk, the results are as shown in Table 1.

Table 1: Data on Musculoskeletal Complaints After Work Between Before and After using Trolley (n=5).

Description	Lifting Water or gas manually			Use Trolley			p*
	Mean	SD	p	Mean	SD	p	
Complaint Musculoskeletal post	44,02	2,56	0,145	33,04	4,17	0,092	0,001

Notes: SD = Standard deviation, p = Significance for normality, p* = Significance for comparability

b. Fatigue

The term fatigue usually indicates a different condition for each individual, but all of them lead to a loss of efficiency and a decrease in work capacity and endurance (Suarbawa, IKGJ and M Yusuf, 2021; Bridger, 2005) state that general fatigue is a condition that is reflected in symptoms of psychological changes in the form of sluggish motor activity and respiration, feelings of pain, heaviness in the eyeballs, weakened motivation, decreased activity that will affect physical and mental activity. Fatigue consists of muscle fatigue and general fatigues. Muscle fatigue is a symptom of extreme pain when the muscles suffer from excessive tension, while general fatigue is a stage marked by a sense of reduced readiness to use energy (Kimberly, 2011) suggests that in general the symptoms of fatigue can start from being very mild to feeling very tired. General fatigue usually occurs at the end of working hours, when the average workload exceeds 30-40% of maximum aerobic power.

Table 2:Worker fatigue Data After Work (n=5).

	Lifting Water or gas manually			Use Trolley			P*
	Mean	SD	P	Mean	SD	p	
Fatigue (*post-test)*	44,11	2,17	0,178	33,03	3,22	0,334	0,001

Notes: SD = Standard deviation, p = Significance for normality, p* = Significance for comparability

4 CONCLUSIONS

Based on the discussion that has been carried out, the following conclusions can be conveyed:

1. The work attitude of workers who have to rely on the waist and wrist muscles causes an increase in musculoskeletal complaints and complaints of fatigue due to a monotonous or repetitive work attitude.
2. The result of designing a trolley with dimensions: 70 cm wide and 140 cm high with a weight of 60 kg, quite simple to move around
3. The results of testing and analysis of musculoskeletal complaints and levels of fatigue are obtained that:
   a. The mean musculoskeletal complaints from workers before working using the trolley was 44.02 (±2.56) and the mean musculoskeletal complaints after working using the trolley was 33.04 (±4.17) which means there was a decrease in musculoskeletal complaints by 24.9%
   b. The average level of fatigue of workers before working using a trolley is 44.11 (±2.17) and the average level of fatigue after working using a trolley is 33.03 (±3.22) which means there is a decrease in the level of fatigue by 25.1%.

ACKNOWLEDGEMENTS

The authors would like to thank the department of research and community service center Bali State Polytechnic and the Ministry Of Education and Culture of Indonesia for the financing of this research.

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